FINAL

Groundwater Monitoring Program Evaluation Report for Sites OT-17, LF-03, and LF-04

Robins Air Force Base
Georgia

Prepared For

Air Force Center for Environmental Excellence
Consultant Operations Division
Brooks Air Force Base,
San Antonio, Texas

May 2001

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PARSONS ENGINEERING SCIENCE, INC.
1700 Broadway, Suite 900 • Denver, Colorado 80290

FINAL

GROUNDWATER MONITORING PROGRAM EVALUATION REPORT

FOR

SITES OT-17, LF-03, AND LF-04

Prepared for the:

Air Force Center for Environmental Excellence
Consultant Operations Division (AFCEE/ERC)
Brooks Air Force Base, Texas

and

Robins Air Force Base
Warner Robins, Georgia

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May 2001

Prepared by:
Parsons Engineering Science, Inc.
1700 Broadway, Suite 900
Denver, CO 80290

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LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ASCE	American Society of Civil Engineers
bgs	below ground surface
CAP	corrective action plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COCs	contaminants of concern
DCBs	dichlorobenzenes
DCE	dichloroethene
FPTA	fire protection training area
gpm	gallons per minute
IRP	Installation Restoration Program
LCDA	laboratory chemical disposal area
MCLs	maximum contaminant levels
PAH	polynuclear aromatic hydrocarbon
Parsons ES	Parsons Engineering Science, Inc.
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
RCRA	Resource Conservation and Recovery Act
ROD	record of decision
RPO	Remedial Process Optimization
SVE	soil vapor extraction
SVOCs	semi-volatile organic compounds
SWMU	solid waste management unit
TAL	target analyte list
TCE	trichloroethene
UST	underground storage tank
VOCs	volatile organic compounds

SECTION 1

INTRODUCTION

The purpose of this document is to present the results of the groundwater monitoring program evaluation for Installation Restoration Program (IRP) sites OT-17, Landfill 3 (LF-03), and Landfill 4 (LF-04) at Robins Air Force Base (AFB) in Warner Robins, Georgia. The current groundwater monitoring programs at these three sites were evaluated to identify potential opportunities to streamline monitoring activities while maintaining an effective program that monitors the performance of the remedial systems and the potential for contaminants to migrate beyond the systems. This groundwater monitoring program evaluation is one of six tasks that have been performed by Parsons Engineering Science, Inc. (Parsons ES) under the Phase II Remedial Process Optimization (RPO) project. The scope of this work was developed in the *Final Work Plan for the RPO Phase II Evaluation at Sites LF-03, LF-04, OT-17, and OT-20, Robins AFB, Georgia* (Parsons ES, 2000) and refined during subsequent discussions with representatives of Robins AFB and the Air Force Center for Environmental Excellence (AFCEE).

The remainder of this introduction provides general site information that is relevant to this evaluation (Section 1.1) and a discussion of the methods that were used to evaluate the groundwater monitoring programs for the four sites (Section 1.2). Following this introduction, the results of the monitoring program evaluation for each of the three sites are presented in Sections 2 through 4. Conclusions and recommendations, including a summary of cost savings associated with the recommendations, are presented in Section 5. Section 6 lists the references cited in this document.

1.1 GENERAL SITE INFORMATION

Robins AFB occupies 8,855 acres and is situated at the eastern edge of the city of Warner Robins, Georgia, approximately 90 miles southeast of Atlanta and 18 miles south of the city of Macon. The Base serves as a worldwide logistics management center for aircraft, missiles, and support systems for the United States Air Force and as a major repair center for aircraft and airborne electronics systems (Earth Tech, 1999).

Ongoing groundwater monitoring activities at Robins AFB are being conducted under the IRP, which began in 1982, to support site characterization and contaminant remediation activities (Earth Tech, 1999). The groundwater monitoring program evaluation presented in this document pertains specifically to sites OT-17, LF-03, and LF-04. The locations of these sites are shown on Figure 1.1. Sites OT-17 and LF-03 are regulated under the Resource Conservation and Recovery Act (RCRA), while LF-04 is regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Robins AFB is located in the Atlantic Coastal Plain physiographic province in central Georgia. There are five hydrogeologic units designated at Robins AFB. They are listed and described as follows from shallow to deep (Geophex, 1998a):

1. Surficial unit – consists of backfill of various materials, usually derived from nearby sources to fill low-lying wetland areas for construction of roads and buildings; generally up to 10 feet thick, but absent in some locations.
2. Quaternary alluvial unit – consists of a variety of fluvial sediments associated with terraces of the Ocmulgee River system, including gravel, sand, clay, silt, and peat, ranging from a few feet to as much as 30 feet in thickness; difficult to distinguish from the underlying Cretaceous deposits; exists only in the eastern portion of Robins AFB.
3. Providence aquifer – consists of cross-bedded, tan to red-brown, fine to coarse, sand and clayey sand, interbedded with lenses of white, tan, and light purple clay of the Providence formation; Cretaceous in age; 80 to 150 feet thick in Robins AFB area; the aquifer is divided into an upper and lower zone at Robins AFB.

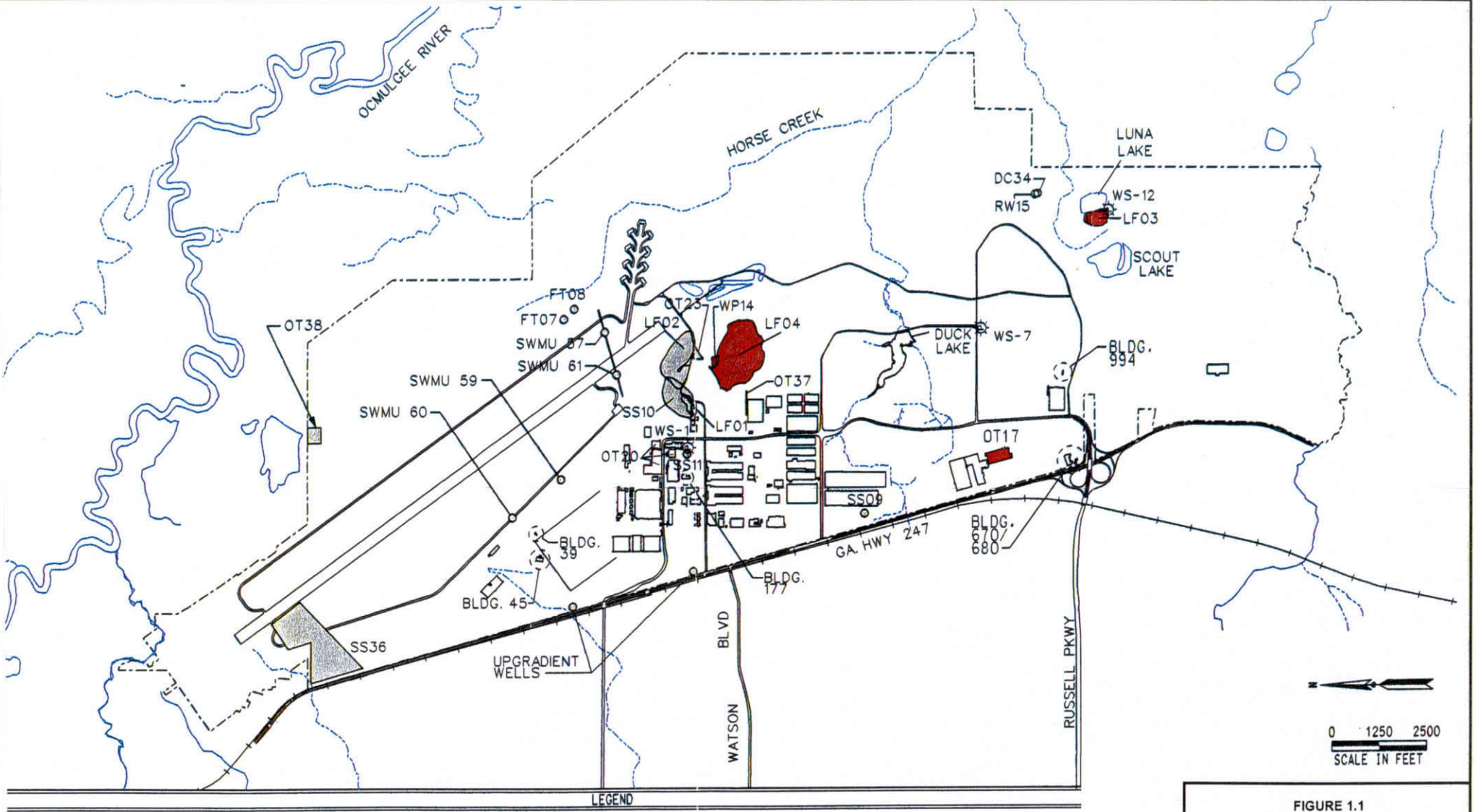

FIGURE 1.1

SITE LOCATIONS

Robins Air Force Base
Warner Robins, Georgia

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Source: Earth Tech, Inc., 1999.

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4. Cusseta aquitard – consists of gray-brown to bluish-gray, slightly micaceous stiff clay and sandy clay; thickness ranges from 40 to 70 feet; Cretaceous in age; a middle sandy unit exists between two relatively continuous clay layers; wells screened in the Cusseta unit are screened in the middle sand.

5. Blufftown aquifer – white to buff-colored, medium to coarse, moderately well-sorted sand with kaolonitic clay lenses and sparse gravel; Cretaceous in age; supplies water to production wells in the area.

Groundwater flow across Robins AFB is generally eastward toward the Ocmulgee River, located approximately one mile east of the eastern border of Robins AFB (Figure 1.1). The river flows south and occupies a broad, swamp-fringed floodplain averaging three miles in width. In general, there is a downward hydraulic gradient in the western portion of Robins AFB and an upward hydraulic gradient in the eastern portion of the Base as groundwater flow approaches the Ocmulgee River floodplain area. Shallow groundwater discharges to local drainages, such as Horse Creek, a tributary to the Ocmulgee River (Figure 1.1).

1.2 METHOD OF EVALUATING THE GROUNDWATER MONITORING PROGRAMS

The development of an effective groundwater monitoring program involves locating monitoring points within a network and developing a site-specific strategy for groundwater sampling and analysis to maximize the amount of relevant information that can be obtained while minimizing costs. Groundwater monitoring programs generally have at least one of the following objectives:

- To characterize the nature and extent of contamination so that the risk to potential receptors can be assessed and appropriate remedial measures can be developed, and/or

- To monitor the performance of a remedial action in meeting remedial goals and mitigating risk to potential receptors.

The effectiveness of a monitoring program in achieving the objectives is generally evaluated qualitatively using professional judgment. In addition, statistical techniques can be used to perform temporal and spatial analyses to assist with the evaluation. Statistical methods can be useful tools in that they provide an objective view of the data, whereas a qualitative evaluation alone is more subjective.

The overall approach used to evaluate the current monitoring programs at sites OT-17, LF-03, and LF-04 is presented in this subsection and is illustrated on Figure 1.2. As shown on Figure 1.2, the first step of the evaluation process was to conduct a review of site information and perform temporal and spatial analyses using qualitative and/or statistical techniques. This information was then used to evaluate whether or not an existing well should continue to be included in the monitoring network for the respective site. Also, this information was used to select appropriate sampling frequencies. The following subsections describe in more detail the review of site information (Section 1.2.1), the temporal and spatial analyses (Section 1.2.2), the evaluation of individual wells in the monitoring network (Section 1.2.3), and the evaluation of sampling frequency (Section 1.2.4). In addition, the various suites of analytes routinely analyzed for at each site were reviewed to access opportunities to reduce analytical costs (Section 1.2.5).

1.2.1 Review of Site Information

Generally, the data needs for site characterization efforts differ from the data needs for evaluating the performance of remedial actions. During site characterization, when very little is known about the site, a relatively large amount of data is collected to identify the source(s) and types of groundwater contamination, the horizontal and vertical extent of the contaminant plume(s), and the potential for the plume(s) to expand and migrate over time. Once characterization is complete, additional data may need to be collected to support the development of remedial alternatives. During the period of remedial operations, which often extends over a number of years, it is important to periodically reassess the monitoring network to be sure that redundant monitoring is not occurring as a result of sampling wells initially installed for site characterization that are no longer

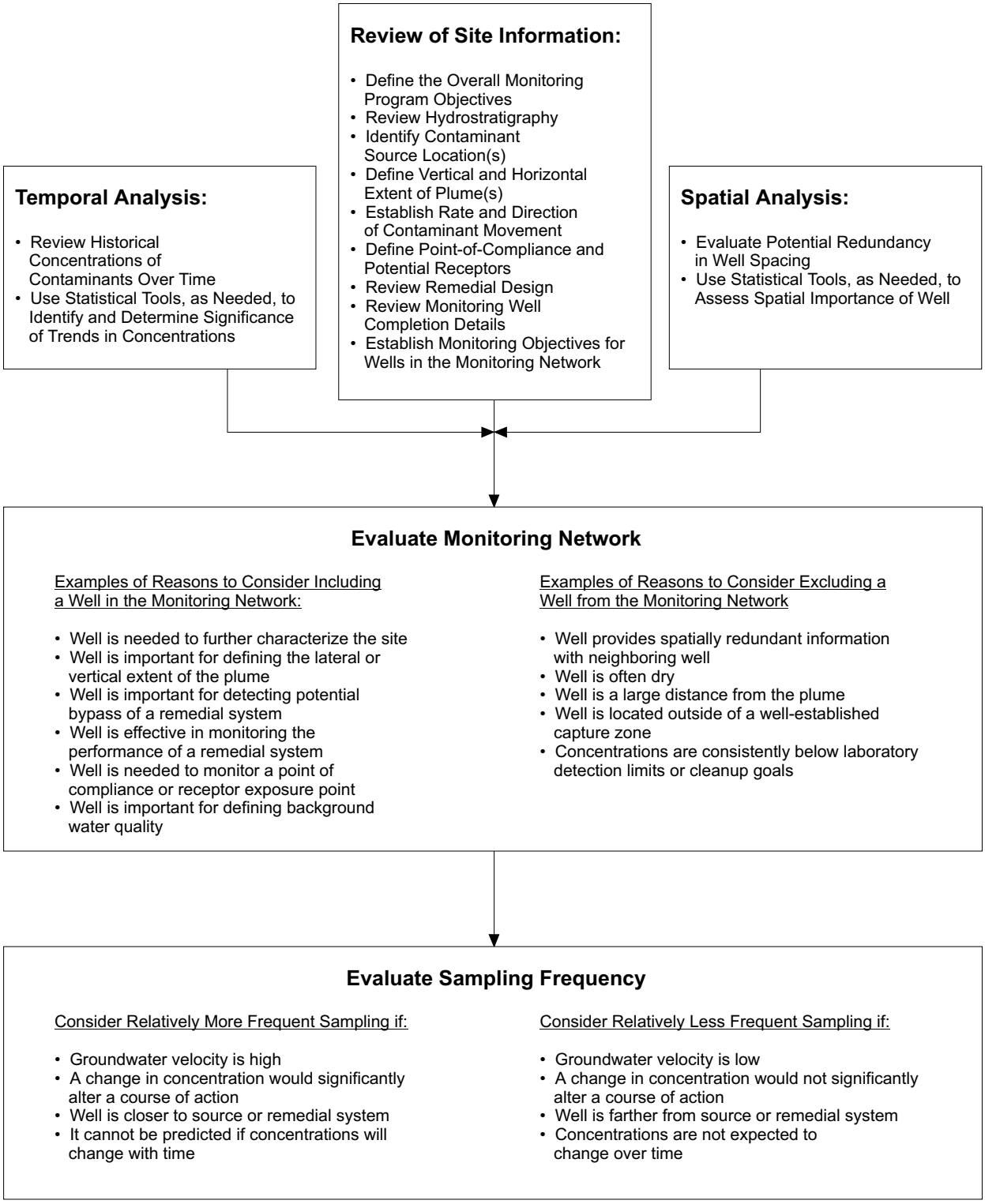

FIGURE 1.2
METHOD FOR EVALUATING THE GROUNDWATER MONITORING PROGRAM
Robins Air Force Base
Warner Robins, Georgia

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needed. Therefore, the first step of this monitoring program evaluation was to define the overall monitoring program and data collection objectives for each of the four sites.

Once the monitoring program objectives were established for each site, relevant site information, such as hydrostratigraphy, groundwater flow direction and rate, plume boundaries, and well-completion details, were reviewed to gain an understanding of the groundwater system that is being monitored and factors that are influencing it (Figure 1.2). The monitoring network within each of the designated hydrogeologic units (i.e., the surficial and quaternary units, etc.) were evaluated separately, in order to account for the variable distribution of contaminants vertically in the subsurface, and for consistency with the annual monitoring reports (e.g., Earth Tech, 1999). Monitoring objectives for each individual well or group of wells in the network were then established so that the importance of each well could be evaluated with respect to its monitoring purpose. Monitoring wells were divided into the following groups for this evaluation:

- Wells located hydraulically upgradient from the contaminant plumes to monitor background water quality,
- Wells located hydraulically cross-gradient from and generally outside of the contaminant plumes to monitor the lateral boundaries of the plume over time,
- Wells located hydraulically downgradient of the contaminant plume to monitor the potential for plume expansion in a downgradient direction, and
- Wells located within the contaminant plumes to monitor plume boundaries and performance of the remedial systems.

Temporal and spatial analyses of groundwater data were conducted along with the site information review to gain a better understanding of temporal trends, plume dynamics, and the spatial importance of monitoring wells. The methods used for conducting temporal and spatial analyses are described below in Section 1.2.2.

1.2.2 Temporal and Spatial Analyses

A temporal analysis is the review of chemical concentrations measured at the same point in an aquifer at different times, whereas a spatial analysis is the review of chemical concentrations measured at different points in the aquifer (laterally and vertically) at the same time. Temporal and spatial data can be examined either visually (qualitatively) or statistically. Although a visual (e.g., graphical) approach can be a very useful and quick method of reviewing data, it is sometimes appropriate and helpful to use a statistical approach for a more objective assessment.

1.2.2.1 Temporal Analysis

A visual temporal analysis involves a review of chemical data presented in the form of tables or graphs, collected from various sampling events over time, and qualitatively assessing whether or not a trend exists in the data. The importance of a trend or lack of trend depends on the monitoring objective and the location of the well. For example, an increasing trend in concentrations at the toe of a plume may be an indication of plume expansion, and thus would be considered important information when assessing the effectiveness of a remedial action. On the other hand, an increasing trend inside of a remedial capture zone may be caused by shifting of "hot spots" resulting from the modification of groundwater flow paths caused by an extraction well. An increasing trend in this situation may be considered less important.

A statistical temporal analysis was conducted on analytical data of selected contaminants of concern (COCs) for sites OT-17, LF-03, and LF-04 using the Mann-Kendall test (Gibbons, 1994) as part of the site review process. The results of this analysis established whether or not a temporal trend (increasing or decreasing) exists in a data set for a particular well at a specified confidence limit.

For the majority of the groundwater analytical data reviewed for the three Robins AFB sites, either a significant trend (statistical or visual) in concentrations was not observed or the analyses were consistently below the laboratory detection limits. The absence of significant temporal trends at the sites may be because the plumes have reached a state of equilibrium and/or because the recently implemented remedial systems have not had

sufficient time to alter water quality conditions. Overall, the statistical and visual temporal trend analyses, in itself, did not provide substantial rationale for including or excluding wells from the monitoring networks or for reducing the sampling frequency; however the results provided useful information regarding the overall disposition of the plumes (i.e., whether or not the plumes are receding, stable, or expanding). This information was taken into consideration while evaluating the individual wells in the monitoring program.

1.2.2.2 Spatial Analysis

A visual spatial analysis simply involves a review of the lateral and vertical distribution of monitoring points relative to a contaminant plume and/or remedial systems using maps and cross-sections, then using professional judgment to determine if there is redundancy in monitoring points or if data gaps exist. Statistical techniques can also be applied for a more objective assessment of potential redundancy and data gaps.

A statistical spatial analysis was performed using a kriging technique (Clark, 1987; American Society of Civil Engineers [ASCE], 1990a and 1990b). Kriging involves the use of geostatistics to estimate the value of a variable (e.g., chemical concentrations) at any point within the sampled region based on known sample values at various monitoring locations. To conduct this analysis, sampling points (representing existing wells) were successively eliminated from kriging simulations, and the standard deviations examined, to evaluate if significant loss of information (represented by increases in standard deviations) occurs as the number of sampling points is reduced. This was achieved by comparing the result of the simulation with one well sampling point successively removed with the baseline simulation using all the sampling points. If removal of a particular well from the monitoring network caused very little change in median kriging standard deviation (less than about 1 percent), then that well was regarded as contributing a relatively limited amount of information to the monitoring program. At the conclusion of the kriging simulations, each well was ranked from 1 through x, with x equal to the total number of monitoring wells, to represent the relative importance of the well in the monitoring network (i.e., a rank of "1" indicates that well is the most important based on the kriging results).

The spatial statistical analysis was performed on monitoring data from site OT-17 first to assess the application of this approach to the other three Robins AFB monitoring sites. The results of this analysis were considered to be overly conservative, in that only 3 wells could be considered for removal from the program, whereas 8 wells could be considered for removal from the program based on knowledge of site conditions and professional judgment. Also, there were inconsistencies between the wells that were considered most important from a kriging standpoint and those considered most important based on professional judgment. The results of the OT-17 monitoring program evaluation are discussed in greater detail in Section 2. Based on these results, it was considered most appropriate to conduct only qualitative spatial analyses for the monitoring wells associated with the other three sites using knowledge of site conditions and professional judgment.

1.2.3 Evaluating the Monitoring Network

The importance of each well in the Robins AFB groundwater monitoring networks was evaluated considering a number of factors, including monitoring objectives, site-specific conditions, and the results of temporal-trend, and spatial analyses. Examples of reasons to include or exclude a well in a monitoring network are listed on Figure 1.2. These examples are discussed further below.

Site characterization efforts often require the installation and sampling of a number of wells to define the nature and extent of contamination. This information generally is used to assess potential risks associated with groundwater contamination and to develop a remedial solution. During these efforts, wells need to be strategically placed to define the lateral and vertical boundaries of the plume and to identify preferential pathways of contaminant migration.

By the time remedial actions are implemented at a site, the boundaries of the plume generally have been delineated. If this is the case, the number of wells used to define the extent of the plume can be reduced to a minimum number that would provide adequate information to assess potential changes in the plume over time. The upgradient and lateral boundaries of the plume are less likely to change over time compared to the

downgradient boundary (assuming a sufficient hydraulic gradient in a dominant flow direction), and hence would require fewer monitoring points.

To assess whether a plume is migrating, remaining stable, or receding in size, wells located at the toe of the plume and farther downgradient are monitored. If there is a high level of confidence that a remedial system is containing a plume, such as an extraction system that effectively reverses the hydraulic gradient in the area of the plume, then fewer monitoring points may be required downgradient to monitor potential bypass of contaminants through or around the remedial system. If there is sufficient evidence that a plume is stable or receding due to a remedial system or natural attenuation, then fewer monitoring points would be needed downgradient from the plume.

To evaluate the performance of a remedial action (e.g., groundwater extraction, *in situ* bioremediation, natural attenuation), wells are monitored at various locations within the treatment zone to assess whether the plume concentrations are decreasing with time. Wells located at the plume boundaries also can be used to demonstrate if plume recession is occurring due to remedial activities. Wells located in the remedial zone with the highest concentrations are more useful for monitoring the progress of remediation (i.e., mass removal) over time than wells with lower concentrations.

Monitoring water quality at a point of compliance or a potential receptor exposure point is mainly for confirmation that contamination has not reached that point. The number of monitoring points needed for this confirmation should be small if the extent of contamination and groundwater flow paths are well documented, and an effective remedial strategy is in place.

Background or upgradient water quality is monitored to establish the upgradient extent of the plume and to document whether or not there is potentially an upgradient source of contamination influencing the system. If concentrations of a particular COC in samples from a background well have been below the laboratory detection limit for a number of years, it may be reasonable to conclude that the ambient or upgradient groundwater is uncontaminated and it would be appropriate to exclude the well from the monitoring program. On the other hand, if variable low levels of contamination have been detected

in an upgradient well, it may be useful to include the well in the monitoring program to document the presence of background or upgradient contamination.

A well might be excluded from a monitoring network if it is located too far from the plume to provide useful monitoring data, if it is often dry and does not consistently yield samples, or if it is providing information redundant to that provided by neighboring wells based on a spatial analysis. It also may be appropriate to exclude wells from monitoring if COCs in samples from the well have been consistently below laboratory detection limits or cleanup goals, and are expected to remain so in the future, or if the well is located outside of a well-established capture zone where water quality is not expected to be impacted by future plume migration. It may be appropriate to sample these types of wells less frequently in lieu of excluding them from the monitoring network. See Section 1.2.4 for additional discussion on evaluating sampling frequency.

Monitoring results from operating extraction wells were not included in this evaluation because the data collection objectives for the extraction wells differ from those for the monitoring wells. There are operational factors to consider for extraction well monitoring that are beyond the scope of this evaluation (e.g., estimating mass removal from the subsurface).

The decision to permanently abandon an existing well that has been excluded from the monitoring program should be made on a site-specific basis. Even though a well may not be part of a current monitoring program, it may provide useful future information for preparing the site for closure after remediation objectives have been achieved. Therefore, it is recommended that existing wells that have been excluded from the monitoring program be left intact unless (1) they are damaged, (2) they need to be removed for construction purposes, (3) they do not yield representative water quality data, or (4) there is a high level of confidence that they will not be needed in the future.

Groundwater elevation data provide useful information at a relatively low cost to assess hydraulic containment of a plume and to select strategic monitoring locations to detect potential plume movement over time. It may be appropriate to continue water

level monitoring at select wells that are excluded from the monitoring program based on water quality sampling criteria.

1.2.4 Evaluating Sampling Frequency

Figure 1.2 lists examples of general criteria to consider for selecting sampling frequency. Because the selection of an actual sampling frequency (e.g., semi-annually, annually, biennially) is based on many site-specific factors, the criteria are listed with respect to relative sampling frequencies (i.e., more frequent versus less frequent). The various criteria in Figure 1.2 are discussed below.

In general, more frequent sampling is appropriate in hydrogeologic units with higher groundwater velocities (e.g., clean sands and gravels) than those with low groundwater velocities (e.g., silty, clayey sands). A dissolved COC conceivably could travel 1 to 10 feet per day in a typical clean fluvial deposit, thus relatively frequent sampling may be required to detect plume migration. A plume may travel only 10 feet per year in a silty, clayey deposit and would require relatively infrequent monitoring.

If a change in concentration at a well is not expected to significantly alter the current course of action at a site, then a relatively low sampling frequency should be considered for that well. For example, changes in concentrations in wells located inside an extraction well capture zone likely will not provide a reason to modify operations for many years, thus a relatively low sampling frequency may be appropriate for at least some of the wells inside the capture zone. On the other hand, if contaminant concentrations increase at a well located outside of the capture zone, the system may need to be modified to include capture of contaminants at that location by increasing the extraction rate or adding another extraction well. Thus, more frequent sampling may be appropriate for this type of well.

If the purpose of a well is to monitor a potential release from a source area or the performance of a remedial system, then wells closer to the source or remedial system should be monitored more frequently than wells located farther downgradient. This is because a change in concentration due to a source release or due to remediation would likely be observed first in the wells closer to the source/remedial system. Changes at

these wells may trigger more frequent sampling in the downgradient wells, where the change would be expected to occur at a later time.

If concentrations are expected to be relatively stable in a particular well over time, then a relatively low sampling frequency may be appropriate for that well. Some examples of wells in this category include: (1) upgradient wells that monitor background water quality, (2) wells located outside of a well-established capture zone where there is a high level of confidence that the plume is contained, and (3) wells located downgradient from a plume where it has been demonstrated that the plume is stable or receding due to natural attenuation.

1.2.5 Analyte Suite Review

For each site, the suite of analytes that are routinely analyzed for in groundwater were reviewed to identify potential opportunities to eliminate certain analyses, such as semi-volatile organic compounds (SVOCs), metals, pesticides/polychlorinated biphenyls (PCBs), that may no longer be needed. To achieve this the COCs for each site were reviewed, if available, and a summary of historical detections of compounds in selected analyte suites for each of the sites was prepared and reviewed to qualitatively identify which analytes typically are below maximum contaminant levels (MCLs) or detection limits. In addition, the importance of an analyte suite with respect to defining the overall extent of contamination was evaluated.

SECTION 2

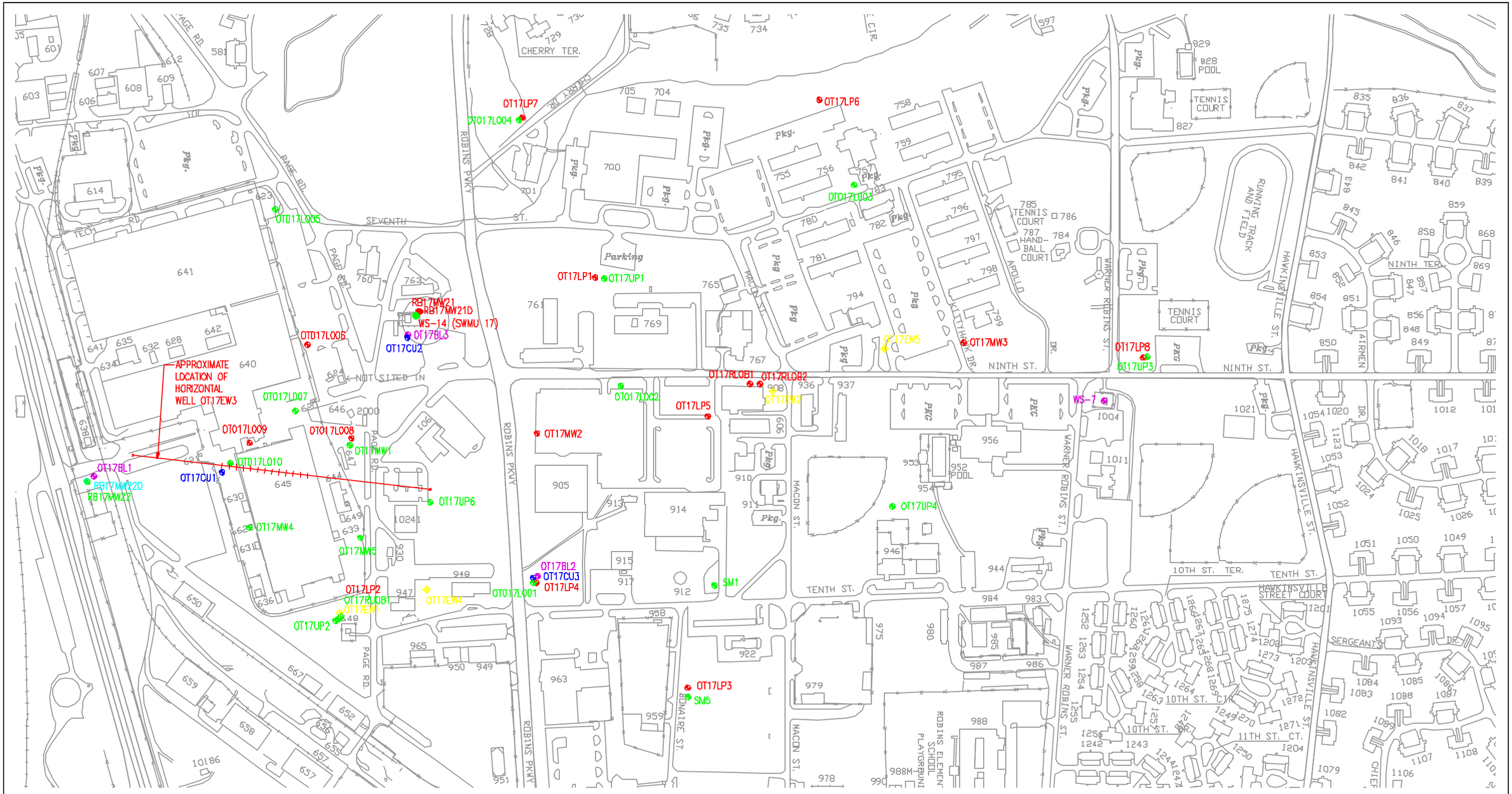
OT-17 MONITORING PROGRAM EVALUATION

The approach used to evaluate the OT-17 monitoring program was discussed in detail in Section 1.2. The following two subsections provide a summary of the site-specific information relevant for evaluating the OT-17 monitoring program (Section 2.1) and the results of the monitoring program evaluation (Section 2.2).

2.1 REVIEW OF INFORMATION FOR SITE OT-17

Site OT-17 is located in the south portion of Robins AFB (see Figure 1.1). Forty-four monitoring wells are included in the current groundwater monitoring program. These wells are shown on a site map in Figure 2.1. OT-17 was established as a RCRA site as a result of trichloroethene (TCE) contamination detected in abandoned water supply well WS-14 (Figure 2.1) during routine sampling of Robins AFB water supply wells (Earth Tech, 1999). Contamination at the site has been attributed to an industrial waste sewer lift station and a former 5,000-gallon underground storage tank (UST) located west of the northwest corner of Building 645 (Earth Tech, 1999). Buildings 640 and 645 are part of an avionics repair facility located west of abandoned well WS-14 (Figure 2.1).

The site is underlain by five distinct water-bearing units that are monitored routinely as part of the OT-17 monitoring program. These units are shown on the stratigraphic column in Figure 2.2. The units include: (1) a relatively thin (10 to 12 feet thick or less) unconfined upper Providence aquifer, (2) a confined upper Providence aquifer averaging in thickness of about 40 feet, (3) a lower Providence aquifer averaging 30 feet thick, (4) the Cusseta aquifer, which is a sandy zone approximately 15-feet thick located within the Cusseta aquitard, and (5) the Blufftown aquifer, which is the unit that most of the base water supply wells are screened in. These five water-bearing units are hydraulically



LEGEND

- MONITORING WELL LOCATION
  - OT17UP6 UNCONFINED UPPER PROVIDENCE WELL
  - OT17MW2 CONFINED UPPER PROVIDENCE WELL
  - RB17MW22D LOWER PROVIDENCE WELL
  - OT17CU1 CUSSETA WELL
  - OT17BLI BLUFFTOWN WELL
    (NOTE: ONLY THE MONITORING WELLS SAMPLED IN THE MONITORING PROGRAM ARE SHOWN)
- LOCATION OF FORMER WATER SUPPLY WELL WS-14
- EXTRACTION WELL LOCATION

FIGURE 2.1

LOCATION OF WELLS IN THE OT-17 MONITORING PROGRAM

ROBINS AFB WARNER ROBINS, GEORGIA

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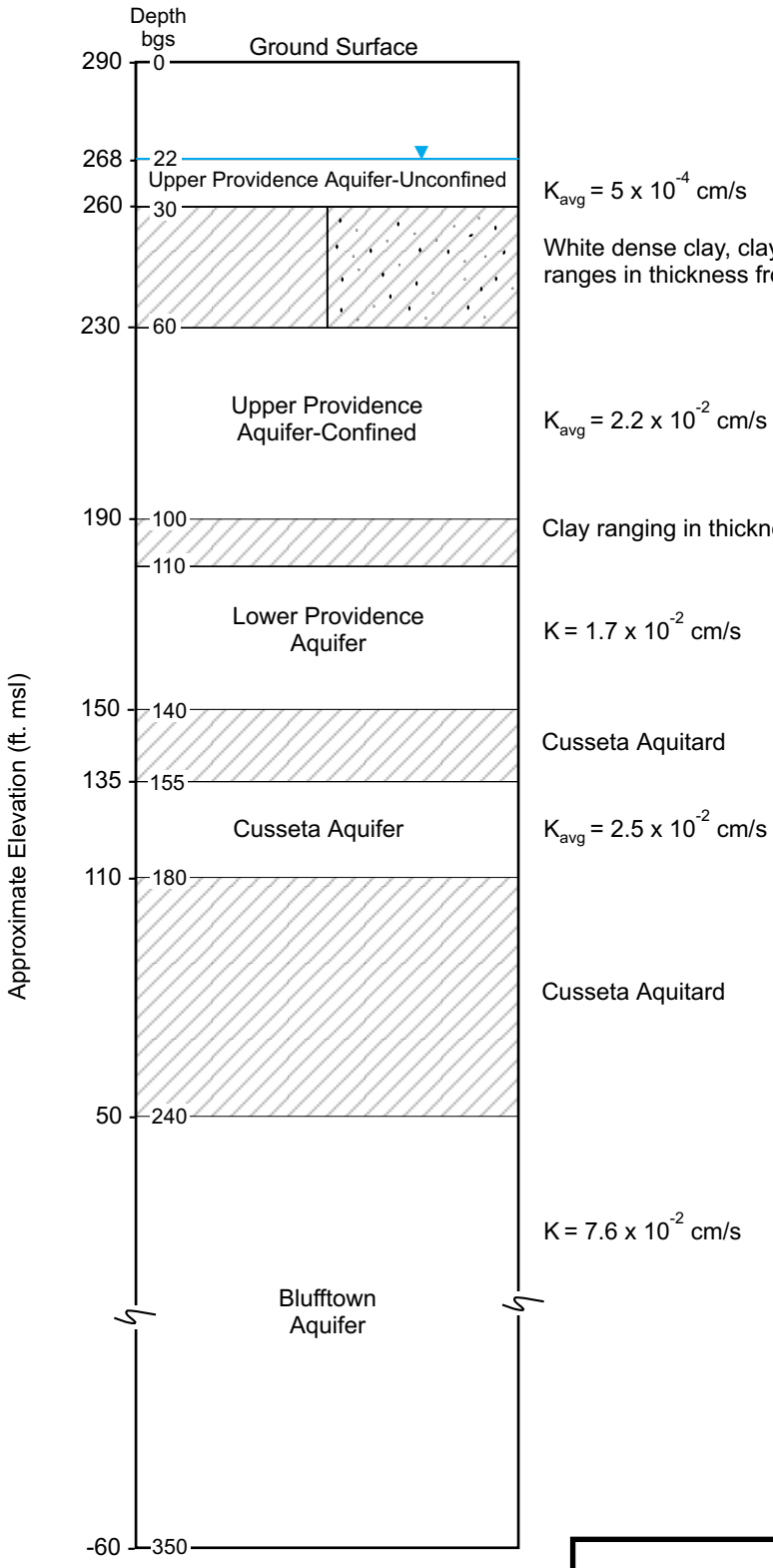

Notes:

1) The stratigraphy shown is based on presentations in Geophex (1998a) with modifications made to the designation of the confined upper Providence and lower Providence aquifers in accordance with Earth Tech / Rust (1999).

2) K is the hydraulic conductivity of the aquifer (from Table 4.8 or pg. 2-4 of Geophex, 1998a).

3) K_{avg} is the arithmetic mean of hydraulic conductivity from various hydraulic tests.

FIGURE 2.2

GENERAL STRATIGRAPHIC COLUMN OF THE OT-17 AREA

Robins Air Force Base
Warner Robins, Georgia

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separated from one another by clay layers of variable thickness (Figure 2.2). The surficial and Quaternary alluvial units that are present in other areas of the base are reportedly absent at site OT-17.

The water table is approximately 22 feet below ground surface (bgs) in the OT-17 area. Groundwater flow is generally to the east following the regional direction of groundwater flow (see Section 1.1). The natural vertical hydraulic gradient is generally downward in the vicinity of OT-17.

A list of the 44 monitoring wells currently sampled in the OT-17 area and well completion details are presented on Table 2.1. There are 19 wells screened in the unconfined upper Providence unit, 17 wells screened in the confined upper Providence unit, 1 well screened in the lower Providence unit, 3 wells screened in the Cusseta unit, and 4 wells screened in the Blufftown aquifer. The wells are sampled semi-annually as part of the OT-17 corrective action plan (CAP) and analyzed for volatile organic compounds (VOCs), SVOCs, and priority pollutant metals.

There are five groundwater extraction wells in operation at OT-17. Wells OT17EW1, OT17EW3, and OT17EW4 extract groundwater from the unconfined upper Providence unit, and wells OT17EW2 and OT17EW5 extract groundwater from the confined upper Providence unit (see Figure 2.1). A soil vapor extraction (SVE) system installed in the contamination source area near the northwest corner of Building 645 was started in early 2001. Monitoring data from the extraction wells were not included in this monitoring program evaluation as discussed in Section 1.2.3.

TCE, *cis*-1,2-dichloroethene (DCE), and tetrachloroethene (PCE) were the COCs selected to represent the extent of the contaminant plume at OT-17 because they are the most commonly detected COCs. To assist in reviewing the data, a statistical summary of these three analytes was prepared (Table 2.2), which includes the number of detections, minimum and maximum detections, the most recent analytical results, and results of the statistical temporal and spatial analyses for each well. In addition, maps illustrating the extent of the contaminant plume and potentiometric surfaces were reviewed. Following a

TABLE 2.1
MONITORING WELLS CURRENTLY SAMPLED AT OT-17
ROBINS AFB
WARNER ROBINS, GEORGIA

	Well ID	Ground Surface Elevation (ft amsl)[a/]	Top of Screen Depth (ft bgs)[b/]	Bottom of Screen Depth (ft bgs)	Screened Unit[c/]
1	OT017L001	290.31	21.6	31.6	UPROV
2	OT017L002	290.92	15.4	25.4	UPROV
3	OT017L003	293.02	26.6	36.6	UPROV
4	OT017L004	285.82	16.35	26.35	UPROV
5	OT017L005	295.02	22.6	32.6	UPROV
6	OT017L006	293.04	89.4	99.4	UPROV-C
7	OT017L007	293.62	23	33	UPROV
8	OT017L008	291.89	89.9	99.9	UPROV-C
9	OT017L009	295.48	89.4	99.4	UPROV-C
10	OT017L010	295.39	26.45	36.45	UPROV
11	OT17BL1	306.38	300	330	BLUFF
12	OT17BL2	290.22	266.5	296.5	BLUFF
13	OT17BL3	286.57	280	310	BLUFF
14	OT17CU1	294.76	160	175	CUSSETA
15	OT17CU2	286.3	150	165	CUSSETA
16	OT17CU3	290.7	165	180	CUSSETA
17	OT17LP1	290.35	89	99	UPROV-C
18	OT17LP2	301.87	89	99	UPROV-C
19	OT17LP3	287.08	90	100	UPROV-C
20	OT17LP4	290.5	80	90	UPROV-C
21	OT17LP5	292.6	90	100	UPROV-C
22	OT17LP6	285.1	90	100	UPROV-C
23	OT17LP7	285.8	90	100	UPROV-C
24	OT17LP8	293.62	76.16	85.6	UPROV-C
25	OT17MW1	292.25	19.5	34.5	UPROV
26	OT17MW2	291.95	63	113	UPROV-C
27	OT17MW3	293.46	63	113	UPROV-C
28	OT17MW4	295.39	20	35	UPROV
29	OT17MW5	293.86	15	30	UPROV
30	OT17RLOB1	293.3	73.16	82.6	UPROV-C
31	OT17RLOB2	292.38	72.86	82.3	UPROV-C
32	OT17RUOB1	301.75	34.96	44.4	UPROV
33	OT17UP1	290.22	24.5	34.5	UPROV
34	OT17UP2	302.76	28	38	UPROV
35	OT17UP3	293.42	30.96	40.4	UPROV
36	OT17UP4	292.06	24.31	33.75	UPROV
37	OT17UP6	292.06	16.26	25.7	UPROV
38	RB17MW21	287.01	33	43	UPROV-C
39	RB17MW21D	287.04	84	94	UPROV-C
40	RB17MW22	306.53	30	40	UPROV
41	RB17MW22D	306.56	123	133	LPROV
42	SM1	290.17	21.5	26.5	UPROV
43	SM5	287.5[d/]	23	38	UPROV
44	WS-7	292.15	266	316	BLUFF

[a/] ft amsl = feet above mean sea level

[b/] ft bgs = feet below ground surface

[c/] UPROV = Upper Providence Aquifer (unconfined)
UPROV-C = Confined Upper Providence Aquifer
CUSSETA = Cusseta Aquitard
BLUFF = Blufftown Aquifer

[d/] elevation is approximate

Notes:

(1) The wells included in this list are currently sampled semi-annually and analyzed for VOCs, SVOCs, and priority pollutant metals.

(2) Extraction wells were not included as part of the evaluation.

TABLE 2.2
OT-17 SUMMARY STATISTICS
ROBINS AFB
WARNER ROBINS, GEORGIA

		TCE							*cis*-1,2-DCE							PCE						
Aquifer	Well Name	Number of Times Analyzed[a/]	Number of Detects[a/]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	June 2000 Concentration (µg/L)	Percent Change When Removed[b/]	Kriging Spatial Analysis Rank[c/]	Number of Times Analyzed[a/]	Number of Detects[a/]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	June 2000 Concentration (µg/L)	Percent Change When Removed[b/]	Kriging Spatial Analysis Rank[c/]	Number of Times Analyzed[a/]	Number of Detects[a/]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	June 2000 Concentration (µg/L)	Percent Change When Removed[b/]	Kriging Spatial Analysis Rank[c/]
Upper Providence	OT017L001	7	7	45.7	600	172	2.00	12	6	6	3	50	15.2	11.96	5	7	7	3.73 J	27	12.5	5.26	14
	OT017L002	7	0			5 U	0.00	19	6	0			5 U	6.54	6	7	0			5 U	4.33	16
	OT017L003	8	1	0.52 J	0.52 J	5 U	2.67	10	7	0			5 U	4.95	19	8	0			5 U	8.11	12
	OT017L004	7	0			5 U	0.67	18	6	0			5 U	44.91	4	7	0			5 U	1.57	17
	OT017L005	8	6	0.4 J	1.55 J	1.55 J	7.33	4	7	0			5 U	6.54	6	8	0			5 U	5.26	14
	OT017L007	8	8	2980	9100	5120	8.00	2	7	5	31.5	84 J	31.5	6.54	6	8	7	26 J	91 J	45.6	68.78	1
	OT017L010	8	8	39800	120000	46700	2.00	12	6	6	890 J	2380 J	1090 J	153.46	1	8	2	72.2	78.3	72.2	11.80	9
	OT17MW1	1	1	14100	14100	14100	5.33	6	1	1	214 J	214 J	214 J	100.84	3	1	1	101	101	101	14.22	8
	OT17MW4	1	1	11.7	11.7	11.7	2.00	12	1	1	3.26 J	3.26 J	3.26 J	6.54	6	1	1	4.75 J	4.75 J	4.25 J	26.29	3
	OT17MW5	1	1	100	100	100	1.33	16	1	1	2.66 J	2.66 J	2.66 J	6.54	6	1	0			5 U	45.10	2
	OT17RUOB1	2	2	2.81 J	1040	2.813 J	8.00	2	2	0			5 U	6.54	6	2	2	1.18 J	12.4 J	1.18 J	6.78	13
	OT17UP1	5	5	12	110	23.1	4.00	7	5	3	0.97 J	19	2.65 J	6.54	6	5	3	1.3 J	3	1.30 J	25.89	4
	OT17UP2	6	6	66.4	100	98.2	2.67	10	6	6	5.94	12	8.11	6.54	6	6	6	19	28.9	26.4	10.80	10
	OT17UP3	3	2	1.17 J	14.8	1.173 J	6.67	5	3	0			5 U	124.58	2	3	0			5 U	1.09	18
	OT17UP4	3	1	9.51	9.51	5 U	4.00	7	3	0			5 U	6.54	6	3	0			5 U	1.00	19
	OT17UP6	2	2	170	2640		4.00	7	2	2	2	15.4		6.54	6	2	1	14.6	14.6		22.23	7
	RB17MW22	9	3	0.24 J	5.76	5 U	13.33	1	7	2	0.7 J	2	5 U	6.54	6	9	5	0.6 J	2.1	5 U	24.41	5
	SM1	3	0			5 U	1.33	16	3	0			5 U	6.54	6	3	0			5 U	9.86	11
	SM5	4	0			5 U	2.00	12	4	0			5 U	6.54	6	4	0			5 U	22.49	6
Upper Providence - Confined	OT017L006	7	5	0.4 J	5	1.52 J	51.37	4	6	0			5 U	0.08	12	7	0			5 U	NA	NA
	OT017L008	8	5	2.3	590	5 U	13.78	11	7	1	0.25 J	0.25 J	5 U	0.08	12	8	0			5 U	NA	NA
	OT017L009	8	8	0.27 J	11.2	7.42	26.43	9	6	1	1.41 J	1.41 J	1.41 J	2.06	10	8	0			5 U	NA	NA
	OT17LP1	5	5	12.8	140	12.8	79.79	1	5	1	5	5	5 U	0.00	17	5	4	3.75 J	9	3.75 J	NA	NA
	OT17LP2	5	3	0.59 J	7.97	7.97	61.86	3	5	2	2.79 J	5	2.79 J	3.14	6	5	1	3	3	5 U	NA	NA
	OT17LP3	5	3	0.23 J	3	1.19 J	79.79	1	5	1	5	5	5 U	5.70	5	5	1	3	3	5 U	NA	NA
	OT17LP4	3	0			5 U	39.35	5	3	0			5 U	3.06	7	3	0			5 U	NA	NA
	OT17LP5	3	3	687	880 J	692	4.79	15	3	0			10 U	1.82	11	3	0			10 U	NA	NA
	OT17LP6	3	3	5.08	9.92	5.08	13.34	12	3	0			5 U	7.43	3	3	0			5 U	NA	NA
	OT17LP7	3	1	8.75	8.75	5 U	30.50	8	3	0			5 U	3.06	7	3	0			5 U	NA	NA
	OT17LP8	3	1	1.39 J	1.39 J	1.39 J	6.41	14	3	0			5 U	16.02	2	3	0			5 U	NA	NA
	OT17MW2	1	1	790	790	790	0.10	17	1	0			50 U	0.08	12	1	0			50 U	NA	NA
	OT17MW3	1	1	79.8	79.8	79.8	31.61	7	1	1	4.03 J	4.03 J	4.03 J	2.73	9	1	1	3.92 J	3.92 J	3.92 J	NA	NA
	OT17RLOB1	2	2	1130	1830	1830	7.50	13	2	2	4 J	6.03	4.00 J	6.94	4	2	2	13	14.6	14.6	NA	NA
	OT17RLOB2	2	2	289	914	914	22.66	10	2	0			50 U	17.42	1	2	0			50 U	NA	NA
	RB17MW21	10	10	8	58	9.4	34.22	6	8	4	0.32 J	0.7 J	5 U	0.08	12	10	5	1 J	4.76 J	2.51 J	NA	NA
	RB17MW21D	9	3	0.2 J	1 J	5 U	1.58	16	7	0			0 U	0.08	12	9	0			5 U	NA	NA
Lower Providence	RB17MW22D	10	4	0.1 J	27.9	5 U	NA	NA	8	0			5 U	NA	NA	10	0			5 U	NA	NA
Cusseta	OT17CU1	6	4	0.66 J	6.75	6.75	NA	NA	6	2	5	5	5 U	NA	NA	6	2	3	3	5 U	NA	NA
	OT17CU2	3	0			5 U	NA	NA	3	1	1.08 J	1.08 J	1.08 J	NA	NA	3	0			5 U	NA	NA
	OT17CU3	3	1	2.17 J	2.17 J	2.17 J	NA	NA	3	0			5 U	NA	NA	3	0			5 U	NA	NA
Blufftown	OT17BL1	5	3	1.3 J	3	1.30 J	NA	NA	5	1	5	5	5 U	NA	NA	5	1	3	3	5 U	NA	NA
	OT17BL2	5	3	1.32 J	4.61 J	1.32 J	NA	NA	5	1	5	5	5 U	NA	NA	5	1	3	3	5 U	NA	NA
	OT17BL3	5	2	3	5.06	5.06	NA	NA	5	2	1.61 J	5	1.61 J	NA	NA	5	1	3	3	5 U	NA	NA
	WS-7	8	1	1 J	1 J	1 U	NA	NA	5	0			5 U	NA	NA	8	0			5 U	NA	NA

TCE = trichloroethene
cis-1,2-DCE = cis-1,2-dichloroethene
PCE = tetrachloroethene
NA = no spatial relationship

J = Concentration is estimated.
U = Constituent was not detected at the reporting limit.
µg/L = micrograms per liter.

[a/] The "Number of Times Analyzed" and the "Number of Detects" represent data from the Robins AFB groundwater database. These values include duplicate samples.

[b/] Represents percent change in median Kriging standard deviation. If less than about one percent, that well is considered to provide only a limited amount of information to the monitoring program.

[c/] The number "1" indicates that well is most important to the monitoring program based on the Kriging results.

preliminary review of the data, it was determined that TCE could be used as an indicator analyte for defining the extent of contamination, because *cis*-1,2-DCE and PCE exist within the TCE plume and at lower concentrations.

The primary monitoring objective for the OT-17 site is to monitor the performance of the remedial system and to detect potential contaminant bypass of the system.

2.2 MONITORING PROGRAM EVALUATION RESULTS FOR SITE OT-17

The importance of each of the 44 monitoring wells in the monitoring network at OT-17 and the well sampling frequencies were evaluated using knowledge of site conditions (described in Section 2.1), results of the statistical summary (Table 2.2), and professional judgment. The results of the evaluations for each individual well in the OT-17 monitoring program is presented in Tables 2.3 through 2.5 for the unconfined upper Providence wells, the confined upper Providence wells, and for wells screened below the upper Providence unit (i.e., lower Providence, Cusseta, and Blufftown wells), respectively. The following discussions summarize the results.

2.2.1 Exclusion of Wells from the Network

Of the 44 wells sampled at OT-17, six are recommended for exclusion from the monitoring program. These are wells OT017L005, OT17MW4, OT17RUOB1, and SM5 in the unconfined upper Providence (noted in boxes on Figure 2.3); and wells OT17LP3 and OT17RLOB2 in the confined upper Providence (noted in boxes on Figure 2.4).

The six wells were recommended for exclusion because (1) the well is upgradient or cross-gradient of the plume and concentrations have been historically below MCLs, (2) the well is inside the remediation zone, but contains lower concentrations than other nearby wells and is thus less suitable for monitoring the performance of the system, or (3) a nearby well screened in the same zone is providing adequate or superior information (see Tables 2.3 and 2.4). The wells screened in the upper Providence units that were retained in the monitoring network are those that provide data that are useful for evaluating the performance of the extraction wells in meeting remedial goals and detecting potential bypass of contaminants downgradient of the system.

TABLE 2.3
OT-17 MONITORING PROGRAM EVALUATION - UNCONFINED UPPER PROVIDENCE WELLS
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Include or Exclude Well	Recommended Sampling Frequency[a/]	Rationale for Including or Excluding a Well
Wells Located Hydraulically Upgradient From TCE Source Area:			
RB17MW22	Include	Annually	Monitors the quality of groundwater coming onto Robins AFB.
Wells Located Hydraulically Cross-Gradient of and Generally Outside of the TCE Plume:			
OT017L004	Include	Annually	Defines lateral extent of plume on north side.
OT017L005	Exclude		TCE, PCE, and *cis* -1,2-DCE below MCLs in 7 samples collected over 7 years; it is not likely plume will migrate to this well in the future because it is located 250 ft cross-gradient of plume boundary.
SM5	Exclude		TCE, PCE, and *cis* -1,2-DCE below MCLs in 4 samples collected over 4 years; indicates plume has not migrated laterally to this point. Well SM1 is better located to detect lateral/downgradient migration.
Wells Located Hydraulically Downgradient of the Outermost Extent of the TCE Plume:			
OT017L002	Include	Annually	Defines downgradient extent of plume and monitors potential future migration of plume downgradient.
OT017L003	Include	Annually	Defines downgradient extent of plume and monitors potential future migration of plume downgradient.
OT17UP3	Include	Annually	Defines downgradient extent of plume and monitors potential future migration of plume downgradient.
OT17UP4	Include	Annually	Defines downgradient extent of plume and monitors potential future migration of plume downgradient.
SM1	Include	Annually	Defines downgradient extent of plume and monitors potential future migration of plume downgradient.
Wells Located Within the TCE Plume:			
OT017L001	Include	Annually	Defines lateral extent of plume on south side; monitors remedial performance.
OT017L007	Include	Annually	Defines source area concentrations; will be used to monitor performance of sourcea area extraction system once operations start.
OT017L010	Include	Annually	Defines source area concentrations; will be used to monitor performance of sourcea area extraction system once operations start.
OT17MW1	Include	Annually	Defines source area concentrations; will be used to monitor performance of sourcea area extraction system once operations start.
OT17MW4	Exclude [b/]		Well is located near source but TCE level is low (11.7 ug/L based on one sampling event); other nearby wells with higher TCE levels more suitable for monitoring remedial performance.

TABLE 2.3 (Continued)
OT-17 MONITORING PROGRAM EVALUATION - UNCONFINED UPPER PROVIDENCE WELLS
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Include or Exclude Well	Recommended Sampling Frequency[a/]	Rationale for Including or Excluding a Well
OT17MW5	Include	Annually	Monitors performance of extraction system.
OT17RUOB1	Exclude[b/]		Well is within 20 feet of extraction well OT17EW1; monitoring of OT17UP2 will provide adequate information to assess remedial performance and migration control monitoring.
OT17UP1	Include	Annually	Well is important for defining the downgradient extent of the plume.
OT17UP2	Include	Annually	Well monitors performance of remedial system and it defines the lateral extent of the plume to the south.
OT17UP6	Include	Annually	Monitors potential migration of contaminants from the source area.

[a/] All wells in the OT-17 monitoring program are currently sampled semi-annually.

[b/] Exclude after four rounds of sampling have been completed to confirm concentrations at that location.

TABLE 2.4
OT-17 MONITORING PROGRAM EVALUATION - CONFINED UPPER PROVIDENCE WELLS
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Include or Exclude Well	Recommended Sampling Frequency[a/]	Rationale for Including or Excluding a Well
Wells Located Hydraulically Upgradient From TCE Source Area:			
none			
Wells Located Hydraulically Cross-Gradient of and Generally Outside of the TCE Plume:			
OT017L006	Include	Annually	Defines lateral extent of the plume to the north.
OT17LP3	Exclude		Well is located approximatly 400 feet cross-gradient of the estimated plume boundary; TCE, PCE, and *cis* -1,2-DCE were below MCLs in 5 samples collected over 5 years.
OT17LP4	Include	Annually	Defines the lateral extent of the plume to the south.
OT17LP7	Include	Annually	Defines lateral extent of the plume to the north.
RB17MW21D	Include	Annually	Defines the lateral extent of the plume to the north; monitors deeper portion of confined Upper Providence.
Wells Located Hydraulically Downgradient of the Outermost Extent of the TCE Plume:			
OT17LP8	Include	Annually	Well is important for defining the downgradient extent of the plume.
Wells Located Within the TCE Plume:			
OT017L008	Include	Annually	Monitors vertical migration of contaminants near the contaminant source area.
OT017L009	Include	Annually	Defines upgradient extent of plume.
OT17LP1	Include	Annually	Monitors performance of remedial system.
OT17LP2	Include	Annually	Defines lateral extent of plume to the south.
OT17LP5	Include	Annually	Monitors performance of remedial system.
OT17LP6	Include	Annually	Defines lateral extent of the plume to the north.
OT17MW2	Include	Annually	Monitors performance of remedial system.
OT17MW3	Include	Annually	Defines downgradient extent of plume; monitors performance of remedial system.
OT17RLOB1	Include	Annually	Monitors performance of remedial system.
OT17RLOB2	Exclude [b/]		Located within 20 to 30 feet of well OT17RLOB1 and screened at same depth interval; well OT17RLOB1 is better for monitoring remedial performance because contaminant concentrations are higher.
RB17MW21	Include	Annually	Defines lateral extent of the plume to the north; monitors upper portion of confined Upper Providence.

[a/] All wells in the OT-17 monitoring program are currently sampled semi-annually.

[b/] Exclude after 4 rounds of sampling has been completed to confirm concentrations at that location.

TABLE 2.5
OT-17 MONITORING PROGRAM EVALUATION -
WELLS SCREENED BELOW THE UPPER PROVIDENCE UNITS
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Unit	Include or Exclude Well	Recommended Sampling Frequency[a/]	Rationale for Including or Excluding Well
RB17MW22D	LPROV	Include	Annually	Monitors the quality of groundwater coming onto Robins AFB.
OT17CU1	CUSSETA	Include	Annually	Monitors potential vertical migration of contaminants.
OT17CU2	CUSSETA	Include	Annually	Monitors potential vertical migration of contaminants.
OT17CU3	CUSSETA	Include	Annually	Monitors potential vertical migration of contaminants.
OT17BL1	BLUFF	Include	Annually	Monitors potential vertical migration of contaminants.
OT17BL2	BLUFF	Include	Annually	Monitors potential vertical migration of contaminants.
OT17BL3	BLUFF	Include	Annually	Monitors potential vertical migration of contaminants.
WS-7	BLUFF	Include	Annually	Monitors potential vertical migration of contaminants.

[a/] All wells in the OT-17 monitoring program are currently sampled semi-annually.

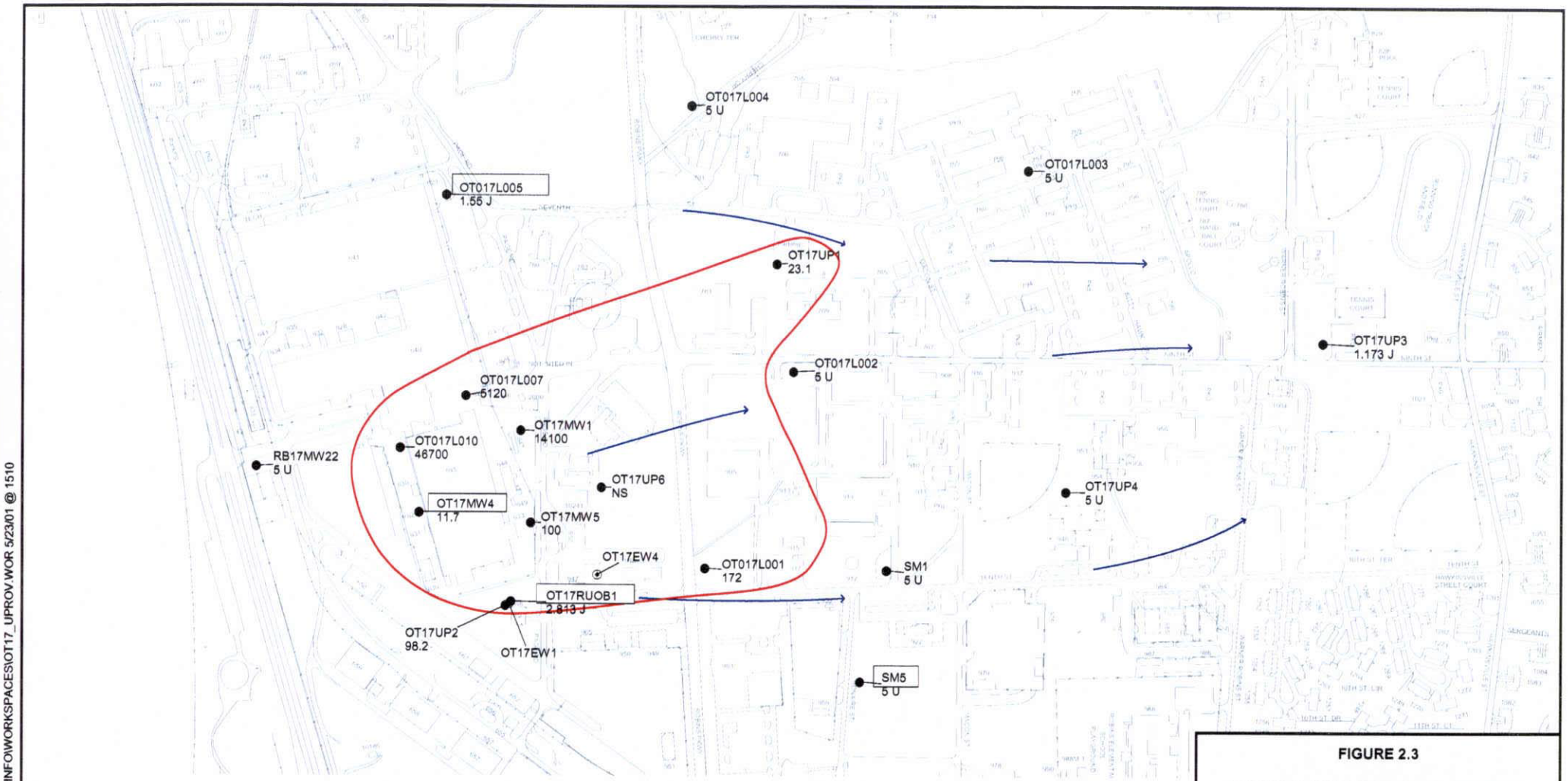


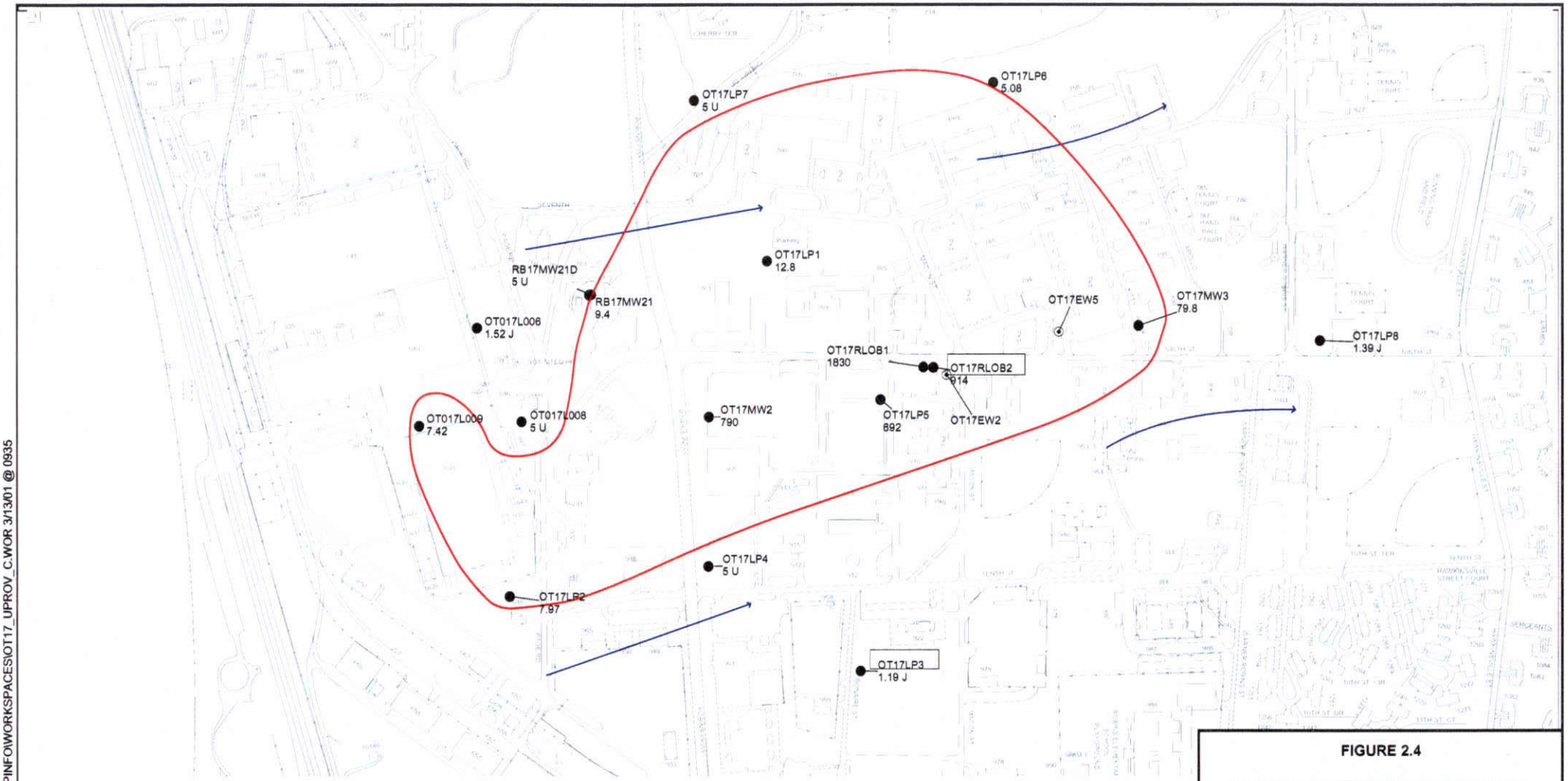
FIGURE 2.3

RESULTS OF THE OT-17 MONITORING PROGRAM EVALUATION FOR THE UNCONFINED UPPER PROVIDENCE UNIT

Robins AFB
Warner Robins, Georgia

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

S:\ES\REMED\RPO\ROBINS\MAPINFO\WORKSPACES\OT17_UPROV.WOR 5/23/01 @ 1510



LEGEND

- WELL LOCATION
  TCE CONCENTRATIONS (µg/L)
  MAY TO JUNE 2000
  NS = NOT SAMPLED
- EXTRACTION WELL (SCREENED IN THE CONFINED UPPER PROVIDENCE UNIT)
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW IN THE CONFINED UPPER PROVIDENCE MAY 2000 (Based on potentiometric surface map in Earth Tech, 2000b.)
- OT17LP3 WELL RECOMMENDED FOR EXCLUSION FROM THE MONITORING PROGRAM
- APPROXIMATE OUTERMOST EXTENT OF SELECTED CONSTITUENT ABOVE THE MCL IN THE CONFINED UPPER PROVIDENCE UNIT FOR:
  TRICHLOROETHENE (TCE); MCL = 5 µg/L

N

0 200 400

Feet

Scale: 1 inch = 400 feet

FIGURE 2.4

RESULTS OF THE OT-17 MONITORING PROGRAM EVALUATION FOR THE CONFINED UPPER PROVIDENCE UNIT

Robins AFB
Warner Robins, Georgia

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

S:\ES\REMED\RPO\ROBINS\MAPINFO\WORKSPACES\OT17_UPROV_C.WOR 3/13/01 @ 0935

As discussed in Section 1.2.2.2, the results of the statistical spatial analyses were not consistent with the results of the qualitative (or visual) spatial evaluation for Site OT-17. Based on the statistical analysis, three wells (OT017L002 and OT17L004 in the unconfined upper Providence and OT17MW2 in the confined upper Providence) were considered not spatially important using criteria discussed in Section 1.2.2.2 (1 percent or less change in median kriging standard deviation when well is removed). However, each of these wells is considered to provide useful information because (1) the well defines the downgradient extent of the plume and monitors potential future migration of the plume, (2) the well defines the lateral extent of the plume, or (3) the well is useful for monitoring the performance of the remedial system (see Tables 2.4 and 2.5). In this case, the qualitative evaluation incorporates more site information and professional judgment into the decision process, and it is considered more reliable and applicable than the statistical approach. Because the three Robins AFB sites are in a stage of interim or final remedial operations where professional judgment is important in assessing monitoring locations, it was considered most appropriate to conduct only qualitative spatial analyses for the remaining two sites.

The wells recommended for exclusion from the OT-17 monitoring program are not recommended for plug and abandonment at this time. Over the course of site remediation and closure, it is likely that these wells will need to be sampled again to confirm that site cleanup goals have been maintained or met at those locations. Measurement of water levels should be continued in the excluded wells to provide information on the effectiveness of plume migration control.

2.2.2 Sampling Frequency Evaluation

A reduction of sampling frequency for all the OT-17 monitoring wells from semi-annually to annually or biennially is recommended after the wells have been sampled at least four times to establish baseline conditions (Tables 2.3 through 2.5). For the unconfined and confined upper Providence units, a reduction in sampling frequency from semi-annually to annually is recommended because there are extraction wells in these units that presumably are capturing the plume and reducing the potential for

downgradient migration of contaminants. Because remediation by extraction generally requires 10 years or more, annual sampling will provide adequate data to assess the performance of the system over time. A reduction of sampling frequency for all the wells screened below the upper Providence unit from semi-annually to annually is recommended because it does not appear that contamination has reached these units and the operation of extraction wells in the upper Providence units is expected to inhibit downward migration. The purpose of sampling these lower zones is to confirm that vertical migration of contaminants is not occurring.

2.2.3 Analyte Suite Review

Groundwater samples collected at OT-17 are currently being analyzed for VOCs, SVOCs, and priority pollutant metals. There are three SVOCs identified as COCs in the final CAP (Geophex, 1998a). They are 1,3-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene with proposed remediation goals of 3,200 µg/L, 75 µg/L, and 70 µg/L, respectively. Of the 44 wells sampled at OT-17, there have been no detections of these compounds above their respective remediation goals (except for one detection of 1,4-dichlorobenzene above the remediation goal out of 24 samples); therefore, it is recommended that SVOC analyses be eliminated for these wells. No metals have been designated as COCs at site OT-17; therefore, it is recommended that the analyses of priority pollutant metals be discontinued.

SECTION 3

LANDFILL 3 MONITORING PROGRAM EVALUATION

The approach used to evaluate the LF-03 monitoring program was discussed in detail in Section 1.2. The following two subsections provide a summary of the site-specific information relevant for evaluating the LF-03 monitoring program (Section 3.1) and the results of the monitoring program evaluation (Section 3.2).

3.1 REVIEW OF INFORMATION FOR SITE LF-03

Site LF-03 is located in the southeastern portion of Robins AFB between Luna and Scout Lakes (Figure 1.1). Thirty-eight monitoring wells are included in the current groundwater monitoring program. These wells are shown on a site map in Figure 3.1. Landfill 3, the laboratory chemical disposal area (LCDA) and fire protection training area 2 (FPTA2) are collectively referred to as site LF-03 (Earth Tech, 1999). Site LF-03 received general refuse, fuel, waste oil, paint residue, and used solvents in the early 1960s. The FPTA2 reportedly operated from the mid-1950s to the mid-1960s and was located within the northern portion of the LF-03 area. Chemicals with expended shelf lives were buried in two unlined pits in the LCDA, located within the LF-03 area, between 1962 and 1964.

Groundwater beneath site LF-03 is being monitored in the surficial unit and upper and lower Providence units. The surficial unit consists of sand and clayey sand. It is hydraulically separated from the Providence unit by a white clay unit that ranges in thickness from 7 to 40 feet beneath LF-03 (Geophex, 1998b). The clay layer is reported to be absent at one well location (RI3-8W) (Geophex, 1998b). The subsurface units are shown on stratigraphic section A-A' in Figure 3.2. The cross section location is shown on Figure 3.1. The Quaternary alluvial unit that is present in other areas of the base is reportedly absent at LF-03.

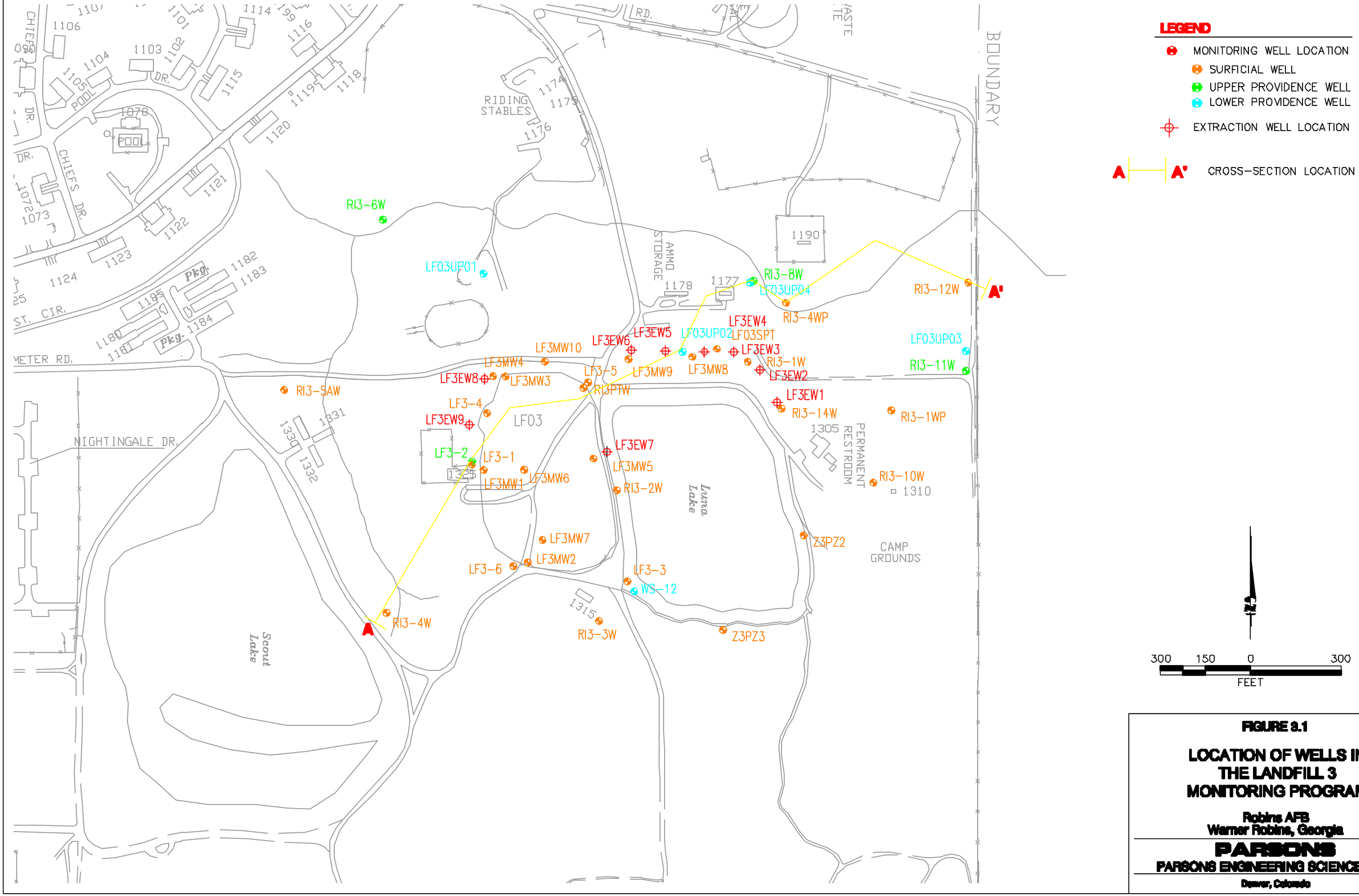
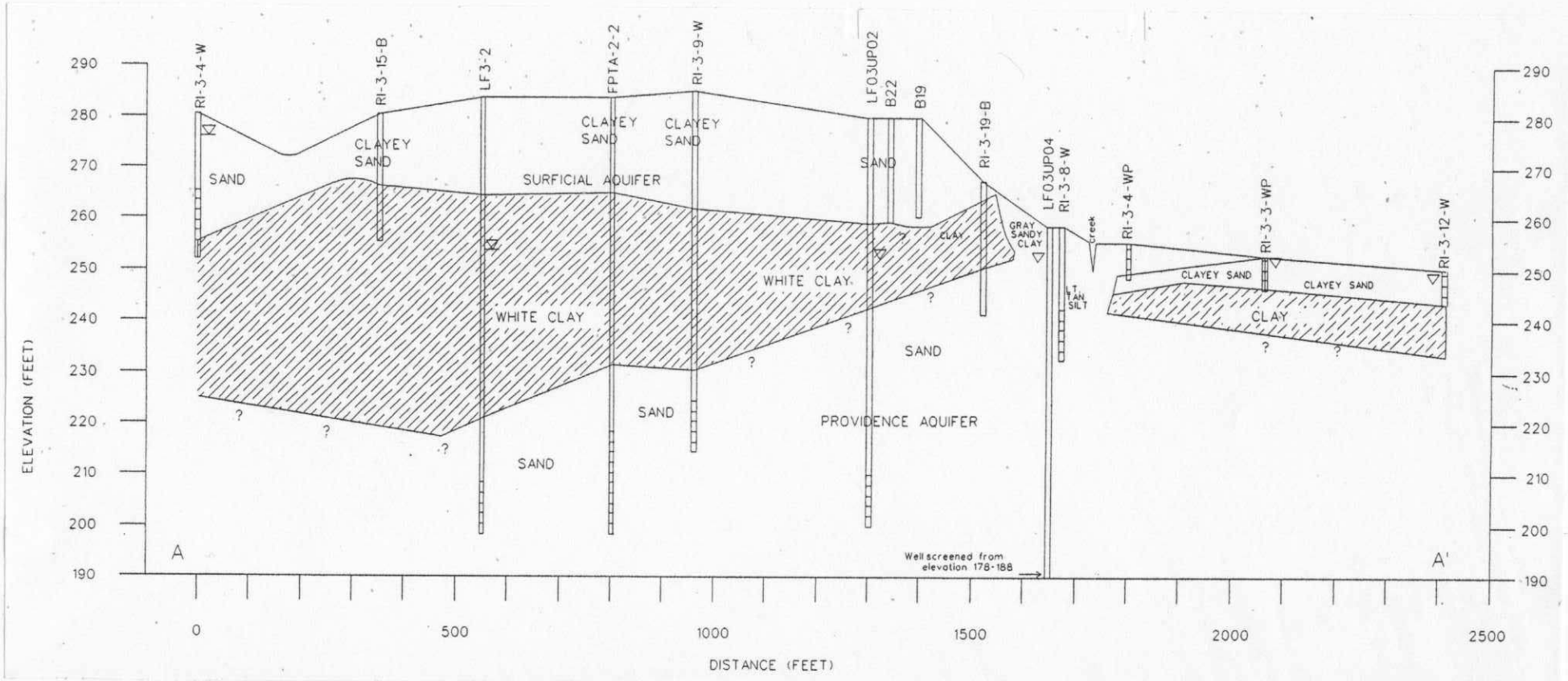


FIGURE 3.1

LOCATION OF WELLS IN THE LANDFILL 3 MONITORING PROGRAM

Robins AFB
Warner Robins, Georgia

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado



Unit	Description of Unit
Surficial Aquifer	Interbedded sand, gravel, silt and clay. Average hydraulic conductivity is 3×10^{-3} cm/s (slug tests) to 3×10^{-2} cm/s (pumping tests).
White Clay	Stiff white or gray micaceous clay; continuous across most of the site. Average hydraulic conductivity is 5.5×10^{-8} cm/s.
Providence Aquifer	Poorly graded sands. Average hydraulic conductivity is 1×10^{-2} cm/s (slug tests) to 1.4×10^{-2} cm/s (pumping test).

Modified from Geophex (1998b).

FIGURE 3.2

STRATIGRAPHIC SECTION A-A' IN THE LANDFILL 3 AREA

Robins Air Force Base
Warner Robins, Georgia

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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The groundwater table exists in the surficial unit several feet bgs in the LF-03 area. Groundwater conditions in the surficial unit appear to be perched. The hydraulic heads in the underlying Providence units are approximately 20 feet lower than the hydraulic heads in the surficial unit, hence a strong downward vertical hydraulic gradient exists. Downward movement of contaminants is inhibited by the presence of the clay unit. Groundwater in the surficial unit generally flows radially away from Luna and Scout Lakes (Figure 3.1). In the Providence units, groundwater flow is eastward to slightly northeastward following the regional groundwater flow direction. The Providence units do not appear to be significantly influenced hydraulically by the lakes.

A list of the 38 monitoring wells currently sampled in the LF-03 area and well completion details are presented on Table 3.1. There are 29 wells screened in the surficial unit, 4 wells screened in the upper Providence unit, and 5 wells screened in the lower Providence unit. The LF-03 wells are sampled semi-annually as part of the CAP and analyzed for VOCs, SVOCs and priority pollutant metals (Geophex, 1998b).

Interim corrective measures at LF-03 include a leachate and gas collection system, a slurry wall keyed into the clay layer beneath the surficial unit, and a clay/synthetic membrane cap. As part of the CAP, nine extraction wells screened in the surficial unit, LF3EW1 through LF3EW9 (see Figure 3.1), and an interceptor trench were constructed and are currently in operation.

The overall monitoring objective for the LF-03 site is to monitor the performance of the remedial system, to detect potential contaminant bypass of the system, and to detect potential vertical migration of contaminants. Chlorobenzene, TCE, naphthalene, and cadmium were the COCs selected to represent the extent of the contaminant plume at LF-03 because they are the most widespread and commonly detected COCs at LF-03. To assist in reviewing the data, a statistical summary of these four analytes was prepared (Table 3.2), which includes the number of detections, minimum and maximum detections, the most recent analytical results, and results of the statistical temporal

TABLE 3.1
MONITORING WELLS CURRENTLY SAMPLED AT LANDFILL 3
ROBINS AFB
WARNER ROBINS, GEORGIA

	Well ID	Ground Surface Elevation (ft amsl)[a/]	Top of Screen Depth (ft bgs)[b/]	Bottom of Screen Depth (ft bgs)	Aquifer[c/]
1	LF03SPT	279.34	5	20	SURF
2	LF03UP01	270.1	70	80	LPROV [d/]
3	LF03UP02	280	70	80	LPROV [d/]
4	LF03UP03	258.6	70	80	LPROV [d/]
5	LF03UP04	258.4	70	80	LPROV [d/]
6	LF3-1	283.39	9	19	SURF
7	LF3-2	283.56	75	85	UPROV
8	LF3-3	280.17	8	18	SURF
9	LF3-4	285.1	10	20	SURF
10	LF3-5	286.11	12	22	SURF
11	LF3-6	282.57	8	18	SURF
12	LF3MW1	286.47	10[e/]	20[e/]	SURF
13	LF3MW2	286.28	10[e/]	20[e/]	SURF
14	LF3MW3	285.46	10[e/]	20[e/]	SURF
15	LF3MW4	283.89	10[e/]	20[e/]	SURF
16	LF3MW5	289.23	10[e/]	20[e/]	SURF
17	LF3MW6	286.44	10[e/]	20[e/]	SURF
18	LF3MW7	286.71	10[e/]	20[e/]	SURF
19	LF3MW8	279.2	8.5	18.5	SURF
20	LF3MW9	282.38	10	20	SURF
21	LF3MW10	277.37	3.5	13.5	SURF
22	RI3-10W	277.72	6	11	SURF
23	RI3-11W	264.86	23	33	UPROV
24	RI3-12W	250	4	9	SURF
25	RI3-14W	279.79	11	21	SURF
26	RI3-1W	278.28	7.3	17.3	SURF
27	RI3-1WP	268.26	1.5	6.5	SURF
28	RI3-2W	283.58	12.3	22.3	SURF
29	RI3-3W	281.59	4.8	9.8	SURF
30	RI3-4W	280.83	15	25	SURF
31	RI3-4WP	254.12	1.5	6.5	SURF
32	RI3-5AW	278.67	25	35	SURF
33	RI3-6W	267.96	22	32	UPROV
34	RI3-8W	257.87	14.8	24.8	UPROV
35	RI3PTW	285.78	15	25	SURF
36	WS-12	279.31	105	125	LPROV
37	Z3PZ2	281.52	10.5	15.5	SURF
38	Z3PZ3	283.15	10.5	15.5	SURF

[a/] ft amsl = feet above mean sea level.

[b/] ft bgs = feet below ground surface.

[c/] SURF = Surficial Aquifer LPROV = Lower Providence Aquifer
UPROV = Upper Providence Aquifer

[d/] These wells are designated as upper Providence wells in EarthTech (1999), and designated as lowe wells in the Robins AFB groundwater database.

[e/] indicates approximate depth

Notes:

(1) The wells included in this list are sampled semi-annually and analyzed for VOCs, SVOCs, and p

(2) The leachate collection wells and wet well were not included in the evaluation.

TABLE 3.2
LF-03 SUMMARY STATISTICS
ROBINS AFB
WARNER ROBINS, GEORGIA

		Chlorobenzene					TCE					Naphthalene					Cadmium				
Aquifer	Well Name	Number of Times Analyzed[a/]	Number of Detects[a/]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	June 2000 Concentration (µg/L)	Number of Times Analyzed[a/]	Number of Detects[a/]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	June 2000 Concentration (µg/L)	Number of Times Analyzed[a/]	Number of Detects[a/]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	June 2000 Concentration (µg/L)	Number of Times Analyzed[a/]	Number of Detects[a/]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	June 2000 Concentration (µg/L)
Surficial	LF03SPT	3	3	143	2160	143	3	2	6.17 J	16.1 J	16.1 J	3	1	1.08 J	1.08 J	1.08 J	3	1	4.9 J	4.9 J	4.9 J
	LF3-1	14	13	30	18000	1100	14	3	16 J	410	5 U	13	8	2 J	29 J	16.4	14	3	0.1 J	12	12
	LF3-3	14	2	1.17 J	2.06 J	1.17 J	14	1	1 J	1 J	5 U	12	0			10 U	14	1	2.7 J	2.7 J	2.7 J
	LF3-4	12	12	23	50700	4230	12	2	5 J	92 J	50 U	11	10	6	29 J	10.8 J	12	2	1.99	23	23
	LF3-5	14	6	0.58 J	97	5 U	14	2	0.67 J	0.9 J	5 U	11	0			10 U	14	2	0.6 J	3.5 J	3.5 J
	LF3-6	14	14	48	1100	740	14	4	2.54 J	23 J	2.54 J	12	7	0.9 J	4 J	1.17 J	14	1	7	7	7
	LF3MW1	7	7	2100	26100	21700	7	1	48 J	48 J	100 U	7	5	9	93.6 J	93.6 J	7	2	0.4 J	42	42
	LF3MW10	1	1	168	168	168	1	1	7.16 J	7.16 J	7.16 J	1	0			10 U	1	1	2.4 J	2.4 J	2.4 J
	LF3MW2	8	7	870	2400	1240	8	4	3.22 J	234	3.22 J	8	7	12.4	44	12.4	7	1	18	18	18
	LF3MW3	7	7	176	1400	176	7	7	7.41 J	160	22.2	7	4	2.3 J	4 J	14.3 UJ	7	2	0.2 J	0.6 J	0.6 J
	LF3MW4	9	9	856	3000	1300	9	2	3.13 J	89.8 J	50 U	9	6	1.09 J	7.5 J	1.09 J	9	1	7	7	7
	LF3MW5	8	8	1400	9330	5860	8	8	23000	57000	34300	8	5	97 J	150	5000 U	8	6	4.5	193	193
	LF3MW6	9	9	3990	49800	35700	9	5	9.36 J	750 J	19.1 J	9	7	13	190	151	9	5	0.7 J	36	35
	LF3MW7	7	6	2800	6100	4000	7	7	44000	190000	53100	7	6	31 J	220	190	7	0			10 U
	LF3MW8	1	1	2650	2650	2650	1	0			100 U	1	1	18.6	18.6	18.6	1	1	7	7	7
	LF3MW9	1	1	202	202	202	1	1	10.5 J	10.5 J	10.5 J	1	1	0.532 J	0.532 J	0.532 J	1	0			5 U
	RI3-10W	14	1	0.45 J	0.45 J	5 U	14	0			5 U	10	0			10 U	14	1	1.5 J	1.5 J	5 U
	RI3-12W	11	1	1 J	1 J	5 U	11	1	0.2 J	0.2 J	5 U	7	0			10 U	13	1	14	14	14
	RI3-14W	14	14	20	390	77.8	14	1	2.62 J	2.62 J	5 U	11	1	0.9 J	0.9 J	10 U	14	2	0.3 J	9.38 J	0.3 J
	RI3-1W	13	13	152	3000 J	152	13	4	2 J	560	25 U	12	8	1.8 J	26	10 U	13	0			5 U
	RI3-1WP	13	2	2.11 J	36.9	2.11 J	13	2	0.2 J	1.26 J	5 U	7	0			10 U	13	1	0.2 J	0.2 J	5 U
	RI3-2W	13	13	5200	16800	12100	13	13	219 J	8300	225 J	13	12	102	490	262	13	2	0.9 J	8	8
	RI3-3W	13	1	4.27 J	4.27 J	4.27 J	13	2	0.3 J	1.2 J	1.20 J	8	0			10 U	13	1	0.6 J	0.6 J	0.6 J
	RI3-4W	14	0			5 U	14	0			5 U	7	0			10 U	14	1	0.1 J	0.1 J	5 U
	RI3-4WP	13	10	0.7 J	17	5 U	13	1	39.5	39.5	5 U	8	0			10 U	13	1	2.04 J	2.04 J	5 U
	RI3-5AW	13	1	0.3 J	0.3 J	5 U	13	1	6	6	5 U	9	0			10 U	13	5	0.1 J	196	5 U
	RI3PTW	14	14	274	7000	274	14	2	33 J	561	25 U	14	13	5	27.8	18.8	14	1	8	8	8
	Z3PZ2	9	0			5 U	9	1	2.95 J	2.95 J	2.95 J	7	0			10 U	0	0			
	Z3PZ3	11	2	0.2 J	24.4	5 U	11	0			5 U	9	1	2.67 J	2.67 J	2.67 J	0	0			
Upper Providence	LF3-2	14	2	0.5 J	7.37	7.37	14	1	0.65 J	0.65 J	5 U	14	0			10 U	14	2	0.1 J	0.2 J	0.2 J
	RI3-11W	12	2	1	1	1.00 J	12	10	1	24	5.26 J	7	0			10 U	14	0			5 U
	RI3-6W	13	1	20.3	20.3	5 U	13	13	10	18.1	13.3	7	0			10 U	13	2	0.2 J	2.7 J	5 U
	RI3-8W	14	14	253	920	515	14	12	11 J	180	10 U	11	5	0.69 J	3 J	10 U	14	1	1.3 J	1.3 J	1.3 J
Lower Providence	LF03UP01	5	1	3.96 J	3.96 J	5 U	5	1	24.3	24.3	5 U	5	0			10 U	5	1	0.4 J	0.4 J	0.4 J
	LF03UP02	5	1	4.76 J	4.76 J	5 U	5	1	2.46 J	2.46 J	2.46 J	5	0			10 U	5	1	0.4 J	0.4 J	0.4 J
	LF03UP03	5	0			5 U	5	1	3.55 J	3.55 J	5 U	5	0			10 U	5	1	0.2 J	0.2 J	0.2 J
	LF03UP04	5	2	2.54 J	6.32	2.54 J	5	0			5 U	5	1	15.8 J	15.8 J	15.8 J	5	1	0.3 J	0.3 J	0.3 J
	WS-12	14	0			5 U	14	0			5 U	8	0			10 U	13	0			5 U

TCE = trichloroethene.
J = Concentration is estimated.
U = Constituent was not detected at the reporting limit.
µg/L = micrograms per liter.

[a/] The "Number of Times Analyzed" and the "Number of Detects" represent data from the Robins AFB groundwater database. These values include duplicate samples.

analyses for each well. In addition, maps illustrating the extent of the contaminant plume and potentiometric surfaces were reviewed.

3.2 MONITORING PROGRAM EVALUATION RESULTS FOR SITE LF-03

The importance of each of the 38 monitoring wells in the monitoring network at LF-03 and the well sampling frequencies were evaluated using knowledge of site conditions (described above in Section 3.1), results of the statistical summary (Table 3.2), and professional judgment. The results of the evaluations for each individual well in the LF-03 monitoring program is presented in Tables 3.3 and 3.4 for the surficial wells and the Providence wells, respectively. The following discussions summarize the results.

3.2.1 Exclusion of Wells from the Network

Of the 38 wells sampled at LF-03, a total of seven are recommended for exclusion from the monitoring program. All seven of these wells are screened in the surficial unit (noted in boxes on Figure 3.3). There were no wells recommended for exclusion from the monitoring program in either the upper or lower Providence (Figure 3.4).

The seven wells in the surficial unit were recommended for exclusion from the monitoring network because: (1) the well is upgradient or cross-gradient of the plume and concentrations have been historically below MCLs or (2) a nearby well screened in the same zone is providing adequate or superior information (see Table 3.3). The wells screened in the surficial unit that were retained in the monitoring network are those that provide data that are useful for evaluating the performance of the extraction wells in meeting remedial goals and detecting potential bypass of contaminants downgradient of the system.

The wells recommended for exclusion from the monitoring program are not recommended for plug and abandonment at this time. Over the course of site remediation and closure, it is likely that these wells will need to be sampled again to confirm that site cleanup goals have been maintained or met at those locations. Measurement of water

TABLE 3.3
LANDFILL 3 MONITORING PROGRAM EVALUATION - SURFICIAL WELLS
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Include or Exclude Well	Recommended Sampling Frequency [a/]	Rationale for Including or Excluding a Well
Wells Located Hydraulically Upgradient From Landfill 3 Plume(s):			
LF3-3	Include	Annually	Helps define upgradient extent of contamination.
RI3-3W	Exclude		Provides similar information as well LF3-3; well has a 5-ft screen.
RI3-4W	Exclude		Upgradient extent of plume is well established at this location.
Z3PZ3	Exclude		Upgradient extent of plume is well established at this location.
Wells Located Hydraulically Cross-Gradient of and Generally Outside of the Landfill 3 Plume(s):			
RI3-1WP	Include	Annually	To confirm lateral extent of plume at this location.
RI3-10W	Exclude		Lateral boundary of plume well-established at this location.
RI3-5AW	Include	Annually	To confirm lateral extent of plume at this location.
Z3PZ2	Exclude		Lateral boundary of plume well-established at this location.
Wells Located Hydraulically Downgradient of the Outermost Extent of the Landfill 3 Plume(s):			
RI3-4WP	Include	Annually	Monitors potential future migration of contaminants.
RI3-12W	Include	Annually	Monitors potential future migration of contaminants.
RI3-14W	Include	Annually	Defines downgradient extent of plumes.
Wells Located Within the Landfill 3 Plume(s):			
LF3-1	Include	Annually	Although this well is not required to monitor plume migration, it is required to monitor the performance of the slurry wall.
LF3-4	Include	Annually	Defines lateral boundary of plume; monitors the performance of the remedial system.
LF3-5	Include	Annually	Although this well is not required to monitor plume migration, it is required to monitor the performance of the slurry wall.
LF3-6	Include	Annually	Although this well is not required to monitor plume migration, it is required to monitor the performance of the slurry wall.
LF3MW1	Include	Annually	Located in plume hot spot; monitors the performance of the remedial system; also defines lateral boundary of plume.
LF3MW2	Include	Annually	Defines upgradient boundary of plumes.
LF3MW3	Include	Annually	Although this well is not required to monitor plume migration, it is required to monitor the performance of the slurry wall.
LF3MW4	Include	Annually	Defines lateral boundary of plume; monitors the performance of the remedial system.
LF3MW5	Include	Annually	Located in plume hot spot; monitors the performance of the remedial system.

TABLE 3.3 (Continued)
LANDFILL 3 MONITORING PROGRAM EVALUATION - SURFICIAL WELLS
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Include or Exclude Well	Recommended Sampling Frequency [a/]	Rationale for Including or Excluding a Well
LF3MW6	Include	Annually	Located in plume hot spot; monitors the performance of the remedial system.
LF3MW7	Include	Annually	Located in plume hot spot; monitors the performance of the remedial system.
LF3MW8	Include	Annually	Monitors the performance of the remedial system.
LF3MW9	Exclude [b/]		Well is located within 200 feet of wells RI3PTW and LF3MW8.
LF3MW10	Include	Annually	Defines downgradient extent of plume; monitors the performance of the remedial system.
LF03SPT	Exclude [b/]		Located within 100 feet of wells LF3MW8 and RI3-1W.
RI3-1W	Include	Annually	Defines downgradient extent of plume; monitors the performance of remedial system.
RI3-2W	Include	Annually	Located in plume hot spot; monitors the performance of the remedial system.
RI3PTW	Include	Annually	Defines downgradient extent of plume; monitors the performance of remedial system.

[a/] All wells in the Landfill 3 monitoring program are currently sampled semi-annually.

[b/] Exclude after four rounds of sampling have been completed to confirm concentrations at that location.

TABLE 3.4
LANDFILL 3 MONITORING PROGRAM EVALUATION - PROVIDENCE WELLS
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Unit	Include or Exclude Well	Recommended Sampling Frequency[a/]	Rationale for Including or Excluding a Well
LF03UP01	LPROV	Include	Annually	Monitors potential vertical migration of contaminants from the surficial unit.
LF03UP02	LPROV	Include	Annually	Monitors potential vertical migration of contaminants from the surficial unit.
LF03UP03	LPROV	Include	Annually	Monitors potential vertical migration of contaminants from the surficial unit.
LF03UP04	LPROV	Include	Annually	Monitors potential vertical migration of contaminants from the surficial unit.
LF3-2	UPROV	Include	Annually	Monitors potential vertical migration of contaminants from the surficial unit.
RI3-11W	UPROV	Include	Annually	Monitors potential vertical migration of contaminants from the surficial unit.
RI3-6W	UPROV	Include	Annually	Monitors potential vertical migration of contaminants from the surficial unit.
RI3-8W	UPROV	Include	Annually	Monitors potential vertical migration of contaminants from the surficial unit.
WS-12	LPROV	Include	Annually	Water is recovered from this well to supply Luna and Scout Lakes, which could enhance flow of dissolved contaminants toward the well and bring the contaminants into contract with human and ecological receptors.

[a/] All wells in the Landfill 3 monitoring program are currently sampled semi-annually.

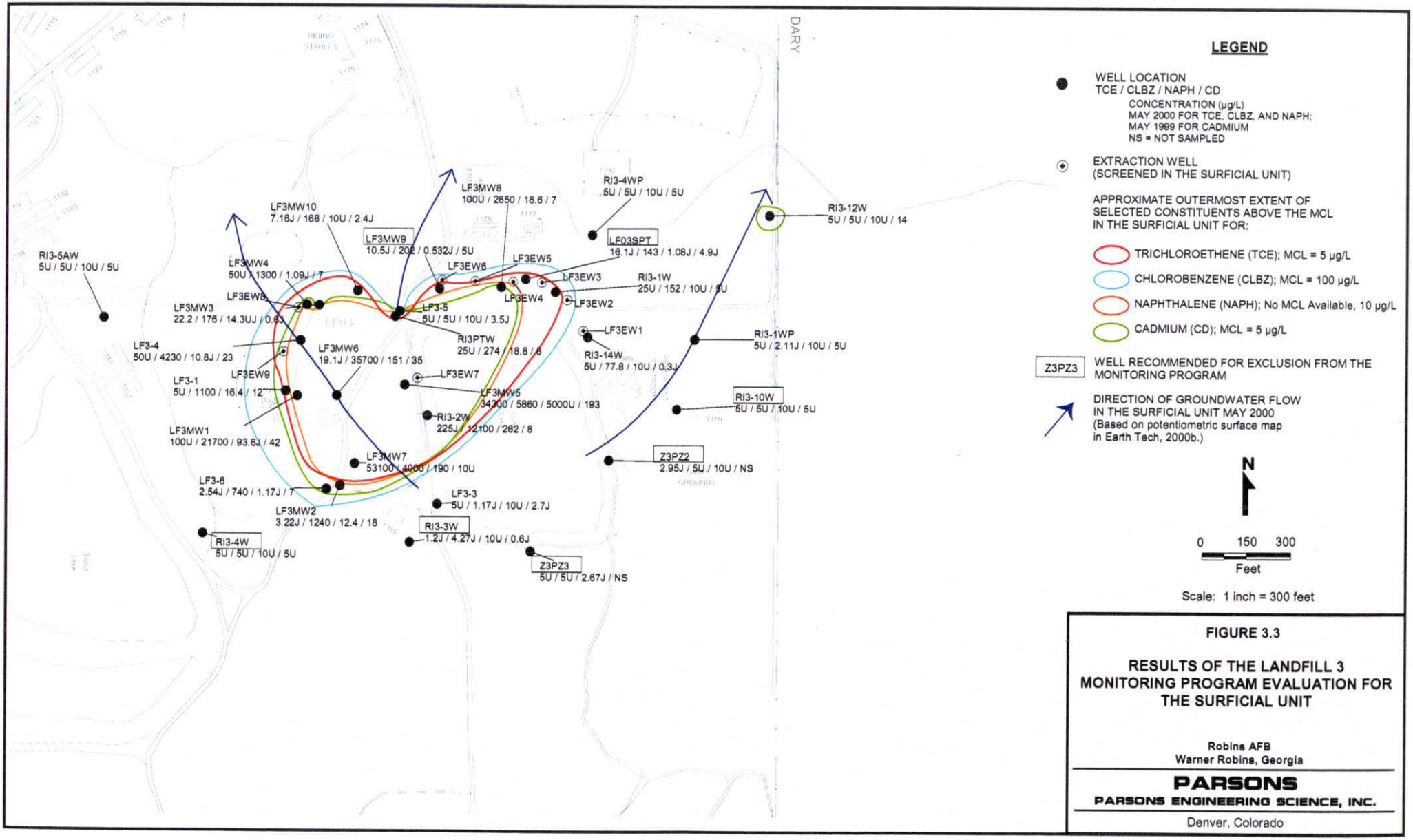

FIGURE 3.3

RESULTS OF THE LANDFILL 3 MONITORING PROGRAM EVALUATION FOR THE SURFICIAL UNIT

Robins AFB
Warner Robins, Georgia

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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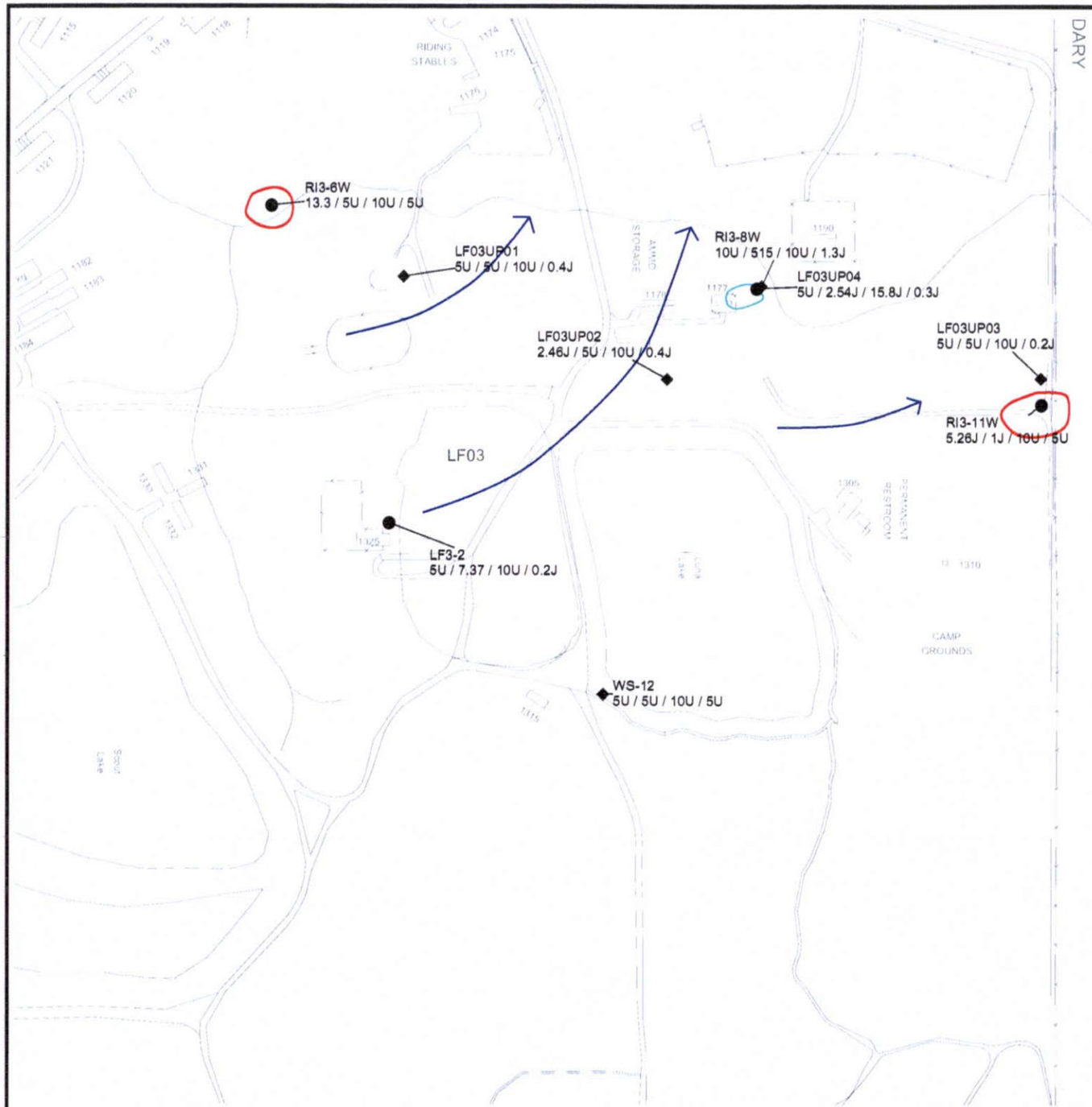

LEGEND

- WELL LOCATION (UPPER PROVIDENCE)
  TCE / CLBZ / NAPH / CD
- WELL LOCATION (LOWER PROVIDENCE)
  TCE / CLBZ / NAPH / CD

CONCENTRATION (µg/L)
MAY 2000 FOR TCE, CLBZ, AND NAPH;
MAY 1999 FOR CADMIUM
NS = NOT SAMPLED

APPROXIMATE OUTERMOST EXTENT OF SELECTED CONSTITUENTS ABOVE THE MCL IN THE SURFICIAL OR PEAT/CLAY UNIT FOR:

- TRICHLOROETHENE (TCE); MCL = 5 µg/L
- CHLOROBENZENE (CLBZ); MCL = 100 µg/L

DIRECTION OF GROUNDWATER FLOW IN THE UPPER AND LOWER PROVIDENCE UNITS MAY 2000
(Based on potentiometric surface map in Earth Tech, 1999.)

N

0 150 300
Feet

Scale: 1 inch = 300 feet

FIGURE 3.4

RESULTS OF THE LANDFILL 3 MONITORING PROGRAM EVALUATION FOR THE UPPER AND LOWER PROVIDENCE UNITS

Robins AFB
Warner Robins, Georgia

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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levels should be continued in the excluded wells to provide information on the effectiveness of plume migration control.

3.2.2 Sampling Frequency Evaluation

A reduction of sampling frequency for all the LF-03 monitoring wells from semi-annually to annually is recommended after the wells have been sampled at least four times to establish baseline conditions (see Tables 3.3 and 3.4). For the surficial unit, a reduction in sampling frequency from semi-annually to annually is recommended because there is a leachate collection system and extraction wells that presumably are capturing the plume and reducing the potential for downgradient and vertical migration of contaminants. Because remediation by extraction generally requires 10 years or more, annual sampling will provide adequate data to assess the performance of the system over time.

A reduction of sampling frequency for the wells screened in the upper and lower Providence units from semi-annually to annually is recommended because remediation in the surficial unit is expected to inhibit further downward migration of contamination to the Providence units. Currently, only small amounts of contamination have migrated downward to the upper Providence unit and it does not appear that significant contamination has reached the lower Providence wells (Figure 3.4). Wells screened in these units provide data to assess whether further degradation of water quality at wells RI3-8W and RI3-11W is occurring or if remediation in the overlying zone is improving water quality at these locations. Another objective of sampling these lower zones is to confirm that vertical migration of contaminants is not occurring.

3.2.3 Analyte Suite Review

Groundwater samples collected at LF-03 are currently being analyzed for VOCs, SVOCs, and priority pollutant metals. Because various constituents (e.g., dichlorobenzenes [DCBs], cadmium) within these analyte suites have been detected at concentrations greater than the cleanup standard specified in the CAP (Geophex, 1998b), recommendations cannot be made at this time to eliminate any of these suites of analyses.

However, because the extent of SVOC and metal contamination is within the VOC plume, it is appropriate to reduce the frequency of sampling for SVOCs and metals to biennially.

SECTION 4

LANDFILL 4 MONITORING PROGRAM EVALUATION

The approach used to evaluate the LF-04 monitoring program was discussed in detail in Section 1.2. The following two subsections provide a summary of the site-specific information relevant for evaluating the LF-04 monitoring program (Section 4.1) and the results of the monitoring program evaluation (Section 4.2).

4.1 REVIEW OF INFORMATION FOR SITE LF-04

Site LF-04 is located in the central-eastern portion of Robins AFB (see Figure 1.1). One hundred monitoring wells are included in the current groundwater monitoring program. These wells are shown on a site map in Figure 4.1. LF-04, the sludge lagoon (WP14), and Third Street storm sewer (OT-37 or solid waste management unit [SWMU] 62) are collectively referred to as site LF-04 (Earth Tech, 1999). LF-04 received general refuse and industrial waste from 1965 to 1978. Site WP14 is an unlined lagoon used from 1962 to 1978 for disposal of industrial waste treatment plant sludges.

Groundwater is being monitored in seven hydrogeologic units at LF-04. These units include the surficial unit, peat/clay, Quaternary alluvium, the upper Providence unit, the lower Providence unit, the Cusseta unit, and the Blufftown aquifer. The upper five units (surficial through both the Providence units) are for the most part, in hydraulic communication with each other. A regional geologic cross-section in the LF-04 area is shown on Figure 4.2.

The groundwater table exists in the surficial unit approximately 10 feet bgs in the LF-04 area. Groundwater flow in the surficial aquifer is variable due to influences from the leachate collection system. In the units beneath the surficial unit, groundwater flow is east to slightly northeast, following the regional direction of groundwater flow. There is a predominantly upward vertical hydraulic gradient from the deeper aquifers (Providence

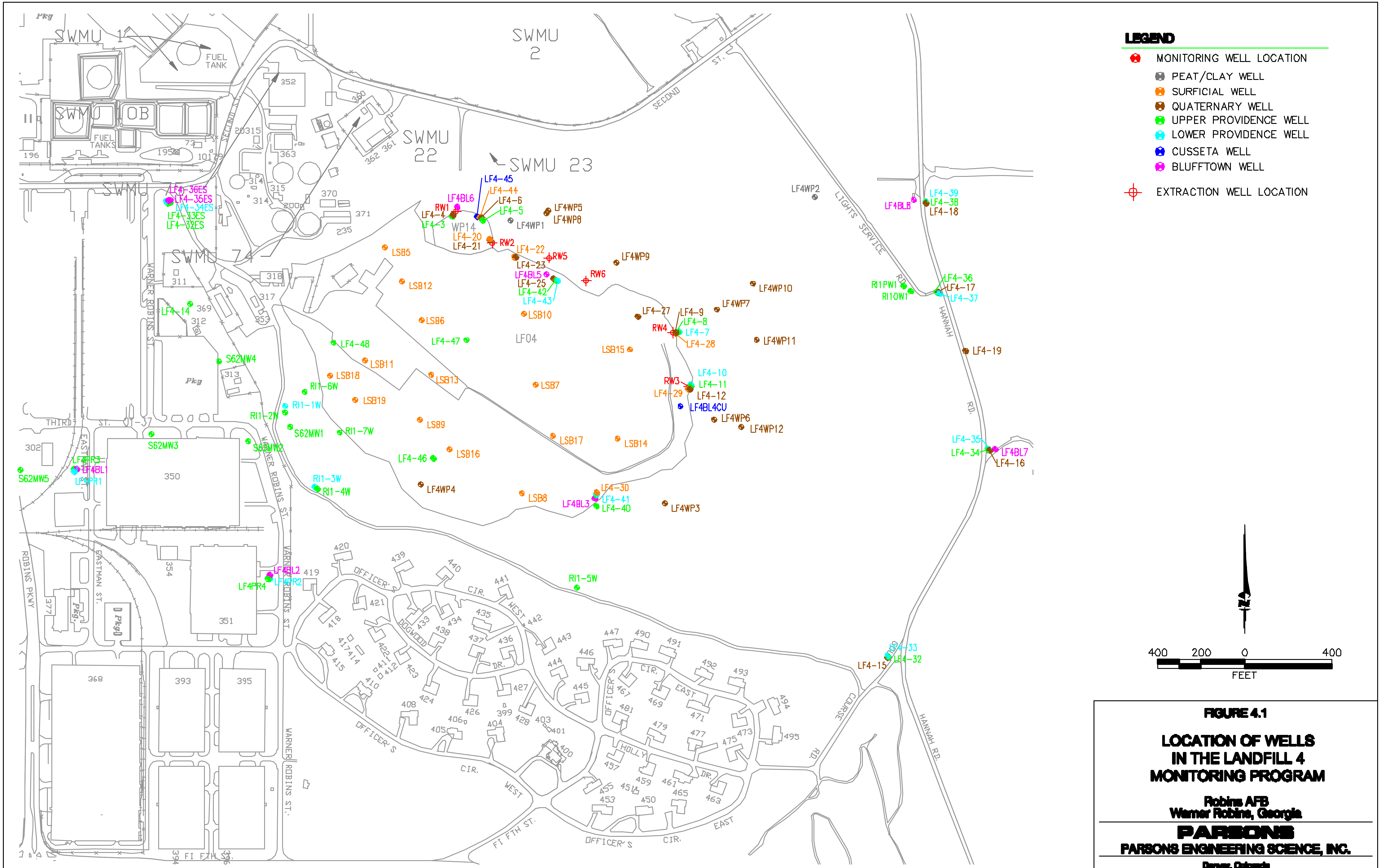
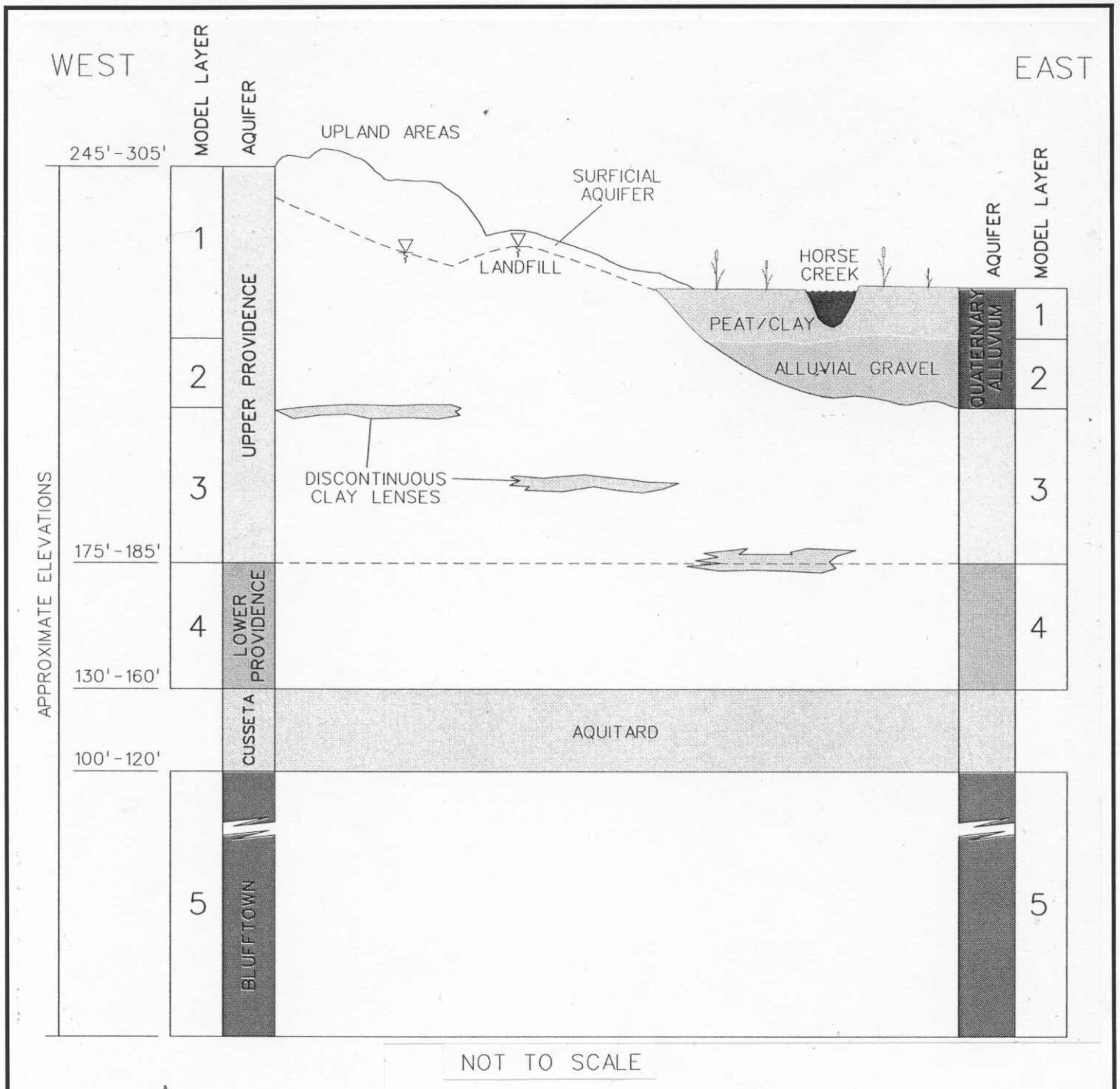


FIGURE 4.1

LOCATION OF WELLS IN THE LANDFILL 4 MONITORING PROGRAM

Robins AFB
Warner Robins, Georgia

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado



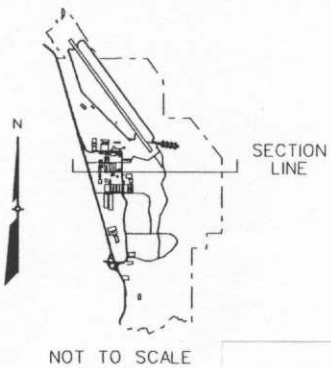


FIGURE 4.2

REGIONAL GEOLOGIC CROSS SECTION IN THE LANDFILL 4 AREA

Robins AFB
Warner Robins, Georgia

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

Source: Earth Tech, 2000a.

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and Blufftown) into the shallow Quaternary alluvium in the LF-04 area, limiting the downward migration of contaminants (Earth Tech, 1999).

A list of the 100 monitoring wells currently sampled in the LF-04 area and well completion details are presented on Table 4.1. There are 20 wells screened in the surficial unit, 2 wells screened in the peat/clay, 24 wells screened in the Quaternary alluvium, 30 wells screened in the upper Providence unit, 14 wells screened in the lower Providence unit, one well screened in the Cusseta, and 9 wells screened in the Blufftown aquifer. All the LF-04 wells are sampled and analyzed annually for VOCs and target analyte list (TAL) compounds, and a subset of these wells is analyzed for polynuclear aromatic hydrocarbons (PAHs) and pesticides/PCBs.

Interim corrective measures that have been implemented at LF-04 include removal of wastes from WP4, operation of a leachate collection system in the surficial unit at the landfill, operation of six extraction wells (RW1 through RW6) in the Quaternary unit around the perimeter of the landfill, and installation of a geosynthetic clay liner over LF-04 and WP14. Operation of extraction well RW1 has been discontinued due to the low recovery of TCE concentrations (Earth Tech, 1999). The preferred final remedy for groundwater at LF-04, as presented in the record of decision (ROD) (Earth Tech, 2000a), is to optimize the existing groundwater interim action. This involves discontinuing operation of the leachate collection system (due to diminishing contaminant concentrations collected), operating two extraction wells at 50 gallons per minute (gpm) each to capture elevated levels of contaminants, and allowing residual contaminants not captured by the system to be reduced by natural attenuation.

The overall monitoring objective for the LF-04 site is to monitor the performance of the final remedial system by verifying a reduction in contaminant concentrations and the effectiveness of natural attenuation mechanisms. The COCs selected to represent the extent of the contaminant plume were benzene, chlorobenzene, and cadmium in the surficial unit; carbon tetrachloride, TCE, and chlorobenzene in the Quaternary unit; and TCE and carbon tetrachloride in the upper Providence unit. These are the most

TABLE 4.1
MONITORING WELLS CURRENTLY SAMPLED AT LANDFILL 4
ROBINS AFB
WARNER ROBINS, GEORGIA

	Well ID	Ground Surface Elevation (ft amsl)[a/]	Top of Screen Depth (ft bgs)[b/]	Bottom of Screen Depth (ft bgs)	Aquifer[c/]
1	LF4-3	254.9	35	50	UPROV
2	LF4-4	254.5	15	25	QUAT
3	LF4-5	253.93	35	50	UPROV
4	LF4-6	253.8	15	25	QUAT
5	LF4-7	249	85	100	LPROV
6	LF4-8	249.32	50	65	UPROV
7	LF4-9	250.65	15	30	QUAT
8	LF4-10	250.22	85	100	LPROV
9	LF4-11	250.74	50	65	UPROV
10	LF4-12	250.33	15	30	QUAT
11	LF4-14	292.9	41	51	UPROV
12	LF4-15	250.06	10.5	20.5	QUAT
13	LF4-16	248.3	11	21	QUAT
14	LF4-17	248.9	13	23	QUAT
15	LF4-18	248.5	8	18	QUAT
16	LF4-19	249	15	25	QUAT
17	LF4-20	253.1	3	8	SURF
18	LF4-21	253.6	13.5	23.5	QUAT
19	LF4-22	255.01	4.5	9.5	SURF
20	LF4-23	255.08	17.5	27.5	QUAT
21	LF4-25	254.72	15.5	25.5	QUAT
22	LF4-27	253.4	21	31	QUAT
23	LF4-28	251.2	3	8	SURF
24	LF4-29	251.25	3	8	SURF
25	LF4-30	253.96	18.5	28.5	QUAT
26	LF4-32	249.7	49	59	UPROV
27	LF4-32ES	293	50	60	UPROV
28	LF4-33	249.6	89	99	LPROV
29	LF4-33ES	292.3	90	100	UPROV
30	LF4-34	249.3	48	58	UPROV
31	LF4-34ES	292.8	125	135	LPROV
32	LF4-35	249.2	88	98	LPROV
33	LF4-35ES	293	243	253	BLUFF
34	LF4-36	248.6	50	60	UPROV
35	LF4-36ES	293.7	330	350	BLUFF
36	LF4-37	248.6	88	98	LPROV
37	LF4-38	248.5	48	58	UPROV
38	LF4-39	248.7	89	99	LPROV
39	LF4-40	253.57	47	57	UPROV
40	LF4-41	253.5	86	96	LPROV
41	LF4-42	254.57	47	57	UPROV
42	LF4-43	255.05	87	97	LPROV

TABLE 4.1 (Continued)
MONITORING WELLS CURRENTLY SAMPLED AT LANDFILL 4
ROBINS AFB
WARNER ROBINS, GEORGIA

	Well ID	Ground Surface Elevation (ft amsl)[a/]	Top of Screen Depth (ft bgs)[b/]	Bottom of Screen Depth (ft bgs)	Aquifer[c/]
43	LF4-44	253.8	3.5	8.5	SURF
44	LF4-45	254.12	88	98	LPROV
45	LF4-46	262.35	21	26	UPROV
46	LF4-47	259.68	22.5	27.5	UPROV
47	LF4-48	263.55	20	25	UPROV
48	LF4BL1	299.45	207	217	BLUFF
49	LF4BL2	290.73	206	216	BLUFF
50	LF4BL3	253.46	171	181	BLUFF
51	LF4BL4CU	256.23	150	160	CUSSETA
52	LF4BL5	254.95	166	176	BLUFF
53	LF4BL6	254.24	140	150	BLUFF
54	LF4BL7	248.23	172	182	BLUFF
55	LF4BL8	250.1	168	178	BLUFF
56	LF4PR1	299.53	130	140	LPROV
57	LF4PR2	290.94	125	135	LPROV
58	LF4PR3	299.37	60	70	UPROV
59	LF4PR4	291.69	60	70	UPROV
60	LF4WP1	248.8	4.6	7.1	PC
61	LF4WP10	246.8	11.7	16.7	QUAT
62	LF4WP11	247.5	11.4	16.4	QUAT
63	LF4WP12	247.5	12	17	QUAT
64	LF4WP2	246.8	2	4.5	PC
65	LF4WP3	248.1	10.3	12.8	QUAT
66	LF4WP4	255.4	7.2	9.7	QUAT
67	LF4WP5	248.2	12	14.5	QUAT
68	LF4WP6	247.8	13	15.5	QUAT
69	LF4WP7	247.8	11.1	13.6	QUAT
70	LF4WP8	250.5	12.2	17.2	QUAT
71	LF4WP9	247.9	9.1	14.1	QUAT
72	LSB5	259.82	6	16	SURF
73	LSB6	259.74	8	18	SURF
74	LSB7	260.22	8	18	SURF
75	LSB8	256.8	7.5	17.5	SURF
76	LSB9	262.06	7.5	17.5	SURF
77	LSB10	257.59	8	18	SURF
78	LSB11	263.78	6.5	16.5	SURF
79	LSB12	259.52	4.7	14.7	SURF
80	LSB13	260.63	7	17	SURF
81	LSB14	258.69	7	17	SURF
82	LSB15	256.76	7	17	SURF
83	LSB16	262.72	7	17	SURF
84	LSB17	258.65	6.5	16.5	SURF

TABLE 4.1 (Continued)
MONITORING WELLS CURRENTLY SAMPLED AT LANDFILL 4
ROBINS AFB
WARNER ROBINS, GEORGIA

	Well ID	Ground Surface Elevation (ft amsl)[a/]	Top of Screen Depth (ft bgs)[b/]	Bottom of Screen Depth (ft bgs)	Aquifer[c/]
85	LSB18	264.35	2	12	SURF
86	LSB19	265.15	1.5	11.5	SURF
87	RI1-1W	272.2	90	100	LPROV
88	RI1-2W	273.3	40	50	UPROV
89	RI1-3W	276.3	90	100	LPROV
90	RI1-4W	276	40	50	UPROV
91	RI1-5W	255.01	17.5	27.1	UPROV
92	RI1-6W	265.4	14.08	23.68	UPROV
93	RI1-7W	269.6	26.17	35.77	UPROV
94	RI1OW1	249	50	60	UPROV
95	RI1PW1	248.47	35	85	UPROV
96	S62MW1	277.38	30	39	UPROV
97	S62MW2	294.12	47	57	UPROV
98	S62MW3	298.35	48	58	UPROV
99	S62MW4	291.2	110	120	UPROV
100	S62MW5	299	38	48	UPROV

[a/] ft amsl = feet above mean sea level.

[b/] ft bgs = feet below ground surface.

[c/] PC = Peat/Clay
SURF = Surficial Aquifer
QUAT = Quaternary Alluvium Aquifer
UPROV = Upper Providence Aquifer
LPROV = Lower Providence Aquifer
CUSSETA = Cusseta Aquitard
BLUFF = Blufftown Aquifer

Notes:
(1) The wells included in this list are sampled as part of the annual basewide groundwater sampling program.
(2) Leachate collection wells and extraction wells were not included in the evaluation.

widespread and commonly detected COCs at LF-04. To assist in reviewing the data, a statistical summary of selected COCs was prepared (Table 4.2), which includes the number of detections, minimum and maximum detections, the most recent analytical results, and results of the statistical temporal analyses for each well. In addition, maps illustrating the extent of the contaminant plume and potentiometric surfaces were reviewed.

4.2 MONITORING PROGRAM EVALUATION RESULTS FOR SITE LF-04

The importance of each of the 100 monitoring wells in the monitoring network at LF-04 and the well sampling frequencies were evaluated using knowledge of site conditions (described above in Section 4.1), results of the statistical analyses (Table 4.2), and professional judgment. The results of the evaluations for each individual well in the LF-04 monitoring program are presented in Tables 4.3 through 4.6 for the surficial wells, the Quaternary wells, the upper Providence wells, and wells below the upper Providence unit, respectively. The following discussions summarize the results.

4.2.1 Exclusion of Wells from the Network

Of the 100 wells sampled at LF-04, a total of 33 are recommended for exclusion from the monitoring program. Of these 33 wells, 10 are screened in the surficial unit (noted in boxes on Figure 4.3), 10 are screened in the Quaternary unit (noted in boxes on Figure 4.4), 9 are screened in the upper Providence (noted in boxes on Figure 4.5), and 4 are screened in units below the upper Providence (Table 4.6, Figure 4.1).

The 10 wells in the surficial unit were recommended for exclusion because: (1) the well is upgradient or cross-gradient of the plume and concentrations have been historically below MCLs, or (2) other wells in the surficial unit contained higher contaminant concentrations and are providing adequate or superior information (see Table 4.3). Of the 15 surficial wells located inside the plume boundary, the 7 that were retained for inclusion in the monitoring network (see Table 4.3) were those with the highest concentrations of the selected COCs. The monitoring wells in the surficial unit

TABLE 4.2
LF-04 SUMMARY STATISTICS
ROBINS AFB
WARNER ROBINS, GEORGIA

		Benzene					Cadmium					Chlorobenzene					TCE [a]					Carbon Tetrachloride				
Aquifer	Well Name	Number of Times Analyzed[a]	Number of Detects[a]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	May 2000 Concentration (µg/L)	Number of Times Analyzed[a]	Number of Detects[a]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	1999 Concentration (µg/L)[b]	Number of Times Analyzed[a]	Number of Detects[a]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	May 2000 Concentration (µg/L)	Number of Times Analyzed[a]	Number of Detects[a]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	May 2000 Concentration (µg/L)	Number of Times Analyzed[a]	Number of Detects[a]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	May 2000 Concentration (µg/L)
Surficial	LF4-20	12	11	1.4	4 J	3.00	12	6	1.9	34	0.2 U	12	5	0.3 J	1.8	1.80	12	0			1 U	12	0			1 U
	LF4-22	11	11	2	7	5.70	11	6	1.6	19.1	0.2 U	11	10	2 J	12	12.0	11	1	6	6	1 U	11	0			1 U
	LF4-28	11	9	0.67 J	4 J	1 U	11	4	1.4	31.1	0.2 U	11	11	2.5	9	2.90	11	2	0.5 J	1 J	1 U	11	0			1 U
	LF4-29	11	11	2.6	12	3.40	11	4	4.8 J	38.3	0.2 U	11	11	2.4	9	5.30	11	1	2 J	2 J	1 U	11	0			1 U
	LF4-44	11	11	5 J	78	12.0	11	9	0.4 J	110	0.4 J	11	10	27 J	280	94.0 D	11	1	54	54	1 U	11	0			1 U
	LSB10	7	7	7.2	12	7.80	7	5	0.64	19.3	0.2 U	7	7	9.3	22	16.0	7	0			1 U	7	0			1 U
	LSB11	6	6	65	100	100	6	4	0.3 J	211	0.3 J	6	6	100	170	120	6	0			10 U	6	0			10 U
	LSB12	5	5	6.4	17	17.0	5	4	0.2 J	8.5	0.2 J	5	4	30	72	98.0 D	5	0			2 U	5	0			2 U
	LSB13	7	7	71	130	89.0	7	7	0.5 J	91.26	0.5 J	7	7	100	190	180	7	1	8.1 J	8.1 J	10 U	7	0			10 U
	LSB14	7	4	5	15 J	11.0 J	7	7	6.2 J	96.07	6.2 J	7	6	200	720	1000 D	7	1	0.2 J	0.2 J	20 U	7	0			20 U
	LSB15	9	7	3	4	3.80	9	9	0.54	29.9	1.6 J	9	8	20	36	32.0 D	9	0			2 U	9	0			2 U
	LSB16	5	5	2	8.4	8.40	5	2	1.4	13.6	0.2 U	5	5	2	18	18.0	5	0			1 U	5	0			1 U
	LSB17	7	7	5	9.5	9.40	7	4	0.5 J	13.8	0.5 J	7	7	36	58	36.0	7	0			2 U	7	0			2 U
	LSB18	4	0				4	2	0.47	10.2		4	0				4	1	0.7 J	0.7 J		4	1	2	2	
	LSB19	2	0				2	2	0.6	8.2		2	0				2	1	460	460		2	0			
	LSB5	6	6	6	23	8.30	6	6	0.9 J	12.6	0.9 J	6	6	25	120	25.0	6	0			2 U	6	0			2 U
	LSB6	5	5	16	30	25.0	5	4	1.8	7.9	1.8 J	5	5	50	74	51.0 J	5	0			2 U	5	0			2 U
	LSB7	6	6	5.7	15	12.0	6	3	2.3 J	25.1	0.2 U	6	5	10	61	36.0 D	6	1	0.9 J	0.9 J	1 U	6	0			1 U
	LSB8	5	0			1 U	5				0.2 U	5	1	0.3 J	0.3 J	1 U	5	5	1.4	2.4	1.40	5	5	0.4 J	1.2	0.88 J
	LSB9	5	5	3.5	17	12.0	5	3	1.1	13.7	0.2 U	5	4	8.4	38	37.0 D	5	0			1 U	5	0			1 U
PC	LF4WP1	12	4	9	54	54.0	12	2	0.2 J	6.8 J	0.2 J	12	3	120	210	370 D	12	8	3	170	10 U	12	3	0.8 J	2 J	10 U
	LF4WP2	12	0			1 U	12	5	1.5	600	0.2 U	12	3	0.68 J	0.8 J	0.68 J	12	0			1 U	12	0			1 U
Quaternary	LF4-12	12	0			1 U	12	1	0.42	0.42	0.2 U	12	0			1 U	12	11	17	140	17.0	12	7	1 J	14 J	2.60
	LF4-15	15	0			1 U	15	0			0.2 U	15	0			1 U	15	3	0.2 J	7	1 U	15	10	0.4 J	3.4	3.40
	LF4-16	13	0			1 U	13	3	0.2	0.8 J	0.8 J	13	0			1 U	13	9	0.5 J	2	1 U	13	1	0.3 J	0.3 J	1 U
	LF4-17	13	0			1 U	13	1	16.17 J	16.17 J	0.2 U	13	0			1 U	13	13	1	10	1.00	13	3	0.4 J	1 J	1 U
	LF4-18	14	0			1 U	13	2	0.63	1 J	0.2 U	14	0			1 U	14	14	1.2	21	1.20	14	4	0.2 J	0.68 J	1 U
	LF4-19	13	0			1 U	13	1	1.1	1.1	0.2 U	13	0			1 U	13	11	1	4	1.00	13	1	0.3 J	0.3 J	1 U
	LF4-21	12	11	0.9 J	33	33.0	12	2	0.3 J	0.5 J	0.5 J	12	12	9	140	86.0	12	10	13	65	10 U	12	4	0.6 J	5	10 U
	LF4-23	11	1	0.2 J	0.2 J	1 U	11	0			0.2 U	11	8	1	9 J	5.00	11	10	67	2500	43.0 D	11	8	4 J	14	5.10
	LF4-25	11	0			1 U	11	1	0.2 J	0.2 J	0.2 J	11	4	0.5 J	6 J	1 U	11	10	63	430	33.0 D	11	11	4.6	28	5.50
	LF4-27	11	0			10 U	11	1	6.19 J	6.19 J	0.2 U	11	0			10 U	11	10	190	720	190	11	11	18	74	18.0
	LF4-30	12	0			2 U	12	0			0.2 U	12	0			2 U	12	12	4.2	13	4.20	12	10	2 J	20	6.30
	LF4-4	11	8	0.89 J	28 J	3.20	11	1	0.7 J	0.7 J	0.7 J	11	10	10	110 J	11.0	11	8	4	22	7.20	11	2	6.6	9.3	9.30
	LF4-6	11	2	26 J	39 J	39.0 J	11	2	0.4 J	1.1	0.4 J	11	9	510	2200	1100	11	11	49 J	23000	140	11				50 U
	LF4-9	12	1	2 J	2 J	1 U	13	1	0.3 J	0.3 J	0.3 J	12	4	0.4 J	9	1 U	13	10	15	410	15.0	13	12	2.8	37 J	2.80
	LF4WP10	12	1	4	4	1 U	12	0			0.2 U	12	0			1 U	12	11	0.68 J	280	2.10	12	8	0.5 J	36	1 U
	LF4WP11	12	0			1 U	12	0			0.2 U	12	0			1 U	12	12	1.9	200	2.50	12	10	0.49 J	20	0.49 J
	LF4WP12	12	0			1 U	12	1	0.2	0.2	0.2 U	12	0			1 U	12	12	4.6	40	4.60	12	11	0.6 J	5 J	1.70
	LF4WP3	11	0			1 U	10	0			0.2 U	11	0			1 U	11	11	4	17	12.0	11	1	0.76 J	0.76 J	0.76 J
	LF4WP4	13	1	0.75 J	0.75 J	0.75 J	13	1	13.3	13.3	0.2 U	13	0			1 U	13	1	1 J	1 J	1 U	13	0			1 U
	LF4WP5	12	0				12	0			0.2 U	12	0				12	12	7	560		12	2	1	5 J	
	LF4WP6	12	0			1 U	12	0			0.2 U	12	0			1 U	12	9	2	6 J	2.80	12	2	0.43 J	0.5 J	0.43 J
	LF4WP7	13	1	2 J	2 J	10 U	13	0			0.2 U	13	8	2	10	10 U	13	13	120	550	150	13	13	8.6 J	54	14.0
	LF4WP8	12	0			5 U	12	0			0.2 U	12	0			5 U	12	12	90	3200	90.0	12	8	5	60	6.70
	LF4WP9	12	0			10 U	12	1	0.2 J	0.2 J	0.2 U	12	4	0.6 J	8 J	10 U	12	11	420	780 J	250 D	12	12	20 J	58	55.0
Upper Providence	LF4-11	12	0			1 U	11	5	0.3 J	6.8	0.9 J	12	0			1 U	12	9	0.62 J	11	1.20	12	0			1 U
	LF4-14	11	0			1 U	10	0			0.3 B	11	0			1 U	11	11	3	15	7.70	11	8	1	4 J	2.00
	LF4-3	13	0			1 U	12	3	0.2	0.2	0.2 J	13	1	2 J	2 J	1 U	13	3	0.52 J	4 J	0.52 J	13	0			1 U
	LF4-32	13	0			1 U	12	1	0.3 J	0.3 J	0.3 J	13	0			1 U	13	1	0.99 J	0.99 J	1 U	13	6	0.5 J	1.1	1.10
	LF4-32ES	16	8	0.4 J	16	1.70	15	3	0.9 J	4.3 J	0.9 J	16	0			1 U	16	14	2	5.4	3.20	16	3	0.3 J	0.4 J	1 U
	LF4-33ES	13	0			1 U	12	2	0.46	1.2 J	1.2 J	13	0			1 U	13	2	0.8 J	2	1 U	13	0			1 U
	LF4-34	13	0			1 U	12	1	0.8 J	0.8 J	0.8 J	13	0			1 U	13	1	1 J	1 J	1 U	13	0			1 U
	LF4-36	13	0			1 U	12	1	0.2 J	0.2 J	0.2 J	13	0			1 U	13	1	1	1	1 U	13	0			1 U
	LF4-38	14	0			1 U	13	1	0.3 J	0.3 J	0.3 J	14	0			1 U	14	1	3 J	3 J	1 U	14	0			1 U
	LF4-40	12	0			1 U	11	0			0.2 U	12	0			1 U	12	1	1	1	1 U	12	0			1 U
	LF4-42	12	0			1 U	11	3	0.4 J	4.73 J	0.4 J	12	0			1 U	12	1	0.3 J	0.3 J	1 U	12	0			1 U
	LF4-46	11	11	12	63	12.0	10	1	0.5 J	0.5 J	0.2 U	11	11	12	76	13.0	11	0			1 U	11	0			1 U
	LF4-47	10	1	0.4 J	0.4 J	1 U	9	0			0.3 B	10	7	2.7	40 J	2.7	10	9	120	350 J	68.0 D	10	8	5 J	26 J	8.50
	LF4-48	9	9	0.45 J	57	0.45 J	8	1	1.2	1.2	0.2 U	9	9	1.1	130	1.10	9	4	0.4 J	22	9.60	9	0			1 U
	LF4-5	13	0			1 U	12	1	0.3	0.3	0.2 U	13	0			1 U	13	2	0.2 J	0.58 J	0.58 J	13	0			1 U
	LF4-8	12	0			1 U	11	0			0.2 U	12	0			1 U	12	11	0.46 J	12	0.46 J	12	4	0.4 J	1 J	1 U
	LF4PR3	13	1	3.4	3.4	1 U	12	0			0.2 U	13	0			1 U	13	5	0.18 J	4 J	0.18 J	13	8	0.4 J	1.6	1 U
	LF4PR4	12	0			1 U	11	0			0.2 U	12	0			1 U	12	12	2 J	9	7.90	12	10	1	3 J	2.70
	RI1-2W	14	0			10 U	12	0			0.2 U	13	0			10 U	14	14	170	880	240	14	14	12	110	30.0
	RI1-4W	12	0			1 U	11	0			0.5 B	12	0			1 U	12	12	11	37	11.0	12	12	3	8 J	5.30
	RI1-5W	12	0			1 U	11	0			0.2 U	12	0			1 U	12	0			1 U	12	3	1 J	2 J	1 U
	RI1-6W	11	0			40 U	10	0			0.2 U	11	0			40 U	11	11	310	1200	580	11	11	38	140	100
	RI1-7W	11	0			5 U	10	0			0.2 U	11	0			5 U	11	11	40	110	60.0	11	11	8 J	21	13.0
	RI1OW1	5	0				5	0			0.2 U	5	1	0.6 J	0.6 J		5	0				5	0			
	RI1PW1	4	0				4	1	1.7 J	1.7 J	1.7 J	4	0				4	0				4	0			
	S62MW1	5	0			10 U	3	0			0.0005 U	5	0			10 U	5	4	280	430	420 D	5	5	35	52	52.0
	S62MW2	4	0			50 U	3	0			0.0005 U	4	0			50 U	4	4	230	610	270	4	4	30	93.2	36.0 J
	S62MW3	5	0			10 U	4	1	0.6	0.6	0.0006	5	1	0.96 J	0.96 J	0.96 J	5	4	640	1320	310 D	5	5	72	155	72.0
	S62MW4	2	1	10.3	10.3	1 U	2	2	0.6	2 J	0.0006	2	0			1 U	2	1	0.5 J	0.5 J	0.5 J	2	0			1 U
	S62MW5	2	0			10 U	2	1	0.6 J	0.6 J	0.0005 U	2	0			10 U	2	1	918	918	800 D	2	2	100	101	100

TABLE 4.2 (Continued)
LF-04 SUMMARY STATISTICS
ROBINS AFB
WARNER ROBINS, GEORGIA

Aquifer	Well Name	Benzene					Cadmium					Chlorobenzene					TCE [a/]					Carbon Tetrachloride				
		Number of Times Analyzed[a/]	Number of Detects[a/]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	May 2000 Concentration (µg/L)	Number of Times Analyzed[a/]	Number of Detects[a/]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	1999 Concentration (µg/L)[b/]	Number of Times Analyzed[a/]	Number of Detects[a/]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	May 2000 Concentration (µg/L)	Number of Times Analyzed[a/]	Number of Detects[a/]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	May 2000 Concentration (µg/L)	Number of Times Analyzed[a/]	Number of Detects[a/]	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	May 2000 Concentration (µg/L)
Lower Providence	LF4-10	12	0			1 U	11	3	0.6 J	6.9	0.6 J	12	0			1 U	12	1	0.19 J	0.19 J	0.19 J	12	0			1 U
	LF4-33	11	0			1 U	12	0			0.2 U	11	0			1 U	11	0			1 U	11	0			1 U
	LF4-34ES	13	0			1 U	12	1	0.2 J	0.2 J	0.2 J	13	0			1 U	13	0			1 U	13	0			1 U
	LF4-35	11	0			1 U	12	1	0.2 J	0.2 J	0.2 J	11	0			1 U	11	0			1 U	11	0			1 U
	LF4-37	14	0			1 U	13	0			0.2 U	14	0			1 U	14	2	0.82 J	1 J	1 U	14	1	0.7 J	0.7 J	1 U
	LF4-39	14	0			1 U	13	2	1.1	1.2	0.2 U	14	0			1 U	14	0			1 U	14	0			1 U
	LF4-41	11	0			1 U	10	1	0.1 J	0.1 J	0.1 J	11	0			1 U	11	1	1 J	1 J	1 U	11	0			1 U
	LF4-43	12	1	7	7	1 U	11	3	0.3 J	3.9 J	0.3 J	12	1	47	47	1 U	12	1	1 J	1 J	1 U	12	0			1 U
	LF4-45	11	0			1 U	10	1	19.94 J	19.94 J	0.2 U	11	0			1 U	11	0			1 U	11	0			1 U
	LF4-7	11	0			1 U	10	0			0.2 U	11	0			1 U	11	0			1 U	11	0			1 U
	LF4PR1	12	0			1 U	11	0			0.2 U	12	1	0.59 J	0.59 J	0.59 J	12	0			1 U	12	0			1 U
	LF4PR2	12	0			1 U	11	1	0.3	0.3	0.2 U	12	0			1 U	12	2	0.4 J	2.3	2.30	12	0			1 U
	RI1-1W	14	0			1 U	13	0			0.2 B	14	0			1 U	14	10	2	21	3.50	14	3	0.55 J	1	0.55 J
	RI1-3W	12	0			1 U	11	2	4.64	5.2	0.9 B	12	0			1 U	12	10	0.5 J	3 J	1.00	12	0			1 U
Cusseta	LF4BL4CU	12	0			1 U	11	0			0.2 U	12	0			1 U	12	0			1 U	12	0			1 U
Blufftown	LF4-35ES	12	0			1 U	11	0			0.2 U	12	0			1 U	12	0			1 U	12	0			1 U
	LF4-36ES	12	1	0.51 J	0.51 J	1 U	11	0			0.2 U	12	0			1 U	12	0			1 U	12	0			1 U
	LF4BL1	13	0			1 U	13	2	0.2 J	8.3	0.2 J	13	0			1 U	13	1	0.4 J	0.4 J	1 U	13	0			1 U
	LF4BL2	12	0			1 U	12	2	3.6 J	21.65	0.2 U	12	0			1 U	12	1	0.64 J	0.64 J	0.64 J	12	0			1 U
	LF4BL3	15	0			1 U	14	1	10.31	10.31	0.2 U	15	0			1 U	15	0			1 U	15	0			1 U
	LF4BL5	11	0			1 U	11	1	0.31	0.31	0.2 U	11	0			1 U	11	0			1 U	11	0			1 U
	LF4BL6	12	0			1 U	12	2	0.35	0.4 J	0.4 J	12	0			1 U	12	1	0.4 J	0.4 J	1 U	12	0			1 U
	LF4BL7	9	0			1 U	8	0			0.2 U	9	0			1 U	9	0			1 U	9	0			1 U
	LF4BL8	7	0			1 U	6	0			0.2 U	7	0			1 U	7	1	4	4	1 U	7	0			1 U

TCE = trichloroethene.
J = Concentration is estimated.
U = Constituent was not detected at the reporting limit shown.
B = Constituent was detected in method blank.
µg/L = micrograms per liter.

[a/] The "Number of Times Analyzed" and the "Number of Detects" represent data from the Robins AFB groundwater database. These values include duplicate samples.
[b/] Cadmium was not analyzed in the majority of the samples collected in 2000, thus 1999 values are used.

TABLE 4.3
LANDFILL 4 MONITORING PROGRAM EVALUATION - SURFICIAL WELLS
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Include or Exclude Well	Recommended Sampling Frequency[a/]	Rationale for Including or Excluding a Well
Wells Located Hydraulically Upgradient From Landfill 4 Plume(s):			
LSB18	Exclude		Exclude after confirming with a fourth sampling round that selected COCs are below MCLs.
Wells Located Hydraulically Cross-Gradient of and Generally Outside of the Landfill 4 Plume(s):			
LSB8	Exclude		Selected COCs below MCLs in 5 sampling rounds over the past 5 years.
Wells Located Hydraulically Downgradient of Landfill 4 Plume(s):			
LF4-20	Include	Annually	Monitors potential future downgradient movement of plume.
LF4-28	Include	Annually	Monitors potential contaminant pypass of the Quaternary extraction system through the surficial aquifer.
LF4-29	Include	Annually	Monitors potential contaminant pypass of the Quaternary extraction system through the surficial aquifer.
LF4WP2[b/]	Include	Biennially	Monitors potential contaminant migration to Horse Creek in the peat/clay unit.
LSB15	Include	Annually	Monitors potential future downgradient movement of plume.
Wells Located Within Landfill 4 Plume(s):			
LF4-44	Include	Annually	Monitors performance of remediation.
LF4-22	Exclude		Other nearby wells contain higher concentrations and are better suited to monitor remediation.
LF4WP1[b/]	Include	Annually	Monitors performance of remediation.
LSB5	Include	Annually	Monitors performance of remediation.
LSB6	Exclude		Other nearby wells contain higher concentrations and are better suited to monitor remediation.
LSB7	Exclude		Other nearby wells contain higher concentrations and are better suited to monitor remediation.
LSB9	Exclude		Other nearby wells contain higher concentrations and are better suited to monitor remediation.
LSB10	Exclude		Other nearby wells contain higher concentrations and are better suited to monitor remediation.
LSB11	Include	Annually	Monitors performance of remediation.
LSB12	Exclude		Other nearby wells contain higher concentrations and are better suited to monitor remediation.
LSB13	Include	Annually	Monitors performance of remediation.
LSB14	Include	Annually	Monitors performance of remediation.
LSB16	Exclude		Other nearby wells contain higher concentrations and are better suited to monitor remediation.
LSB17	Exclude		Other nearby wells contain higher concentrations and are better suited to monitor remediation.
LSB19	Include	Annually	Monitors performance of remediation.

[a/] All wells in the Landfill 4 monitoring program are currently sampled annually.

[b/] Wells LF4WP1 and LF4WP2 are screened in the peat/clay unit.

TABLE 4.4
LANDFILL 4 MONITORING PROGRAM EVALUATION - QUATERNARY WELLS
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Include or Exclude Well	Recommended Sampling Frequency[a/]	Rationale for Including or Excluding a Well
Wells Located Hydraulically Upgradient From Landfill 4 Source Area:			
none			
Wells Located Hydraulically Cross-Gradient of and Generally Outside of the Landfill 4 Plume(s):			
LF4WP4	Exclude		Selected COCs generally below MCLs in 14 sampling rounds over the past 12 years.
LF4-15	Exclude		Located over 1,000 feet from landfill and not located directly downgradient; selected MCLs generally below MCLs.
Wells Located Hydraulically Downgradient of the Outermost Extent of the Landfill 4 Plume(s):			
LF4-16	Include	Annually	Monitors potential bypass of contaminants through the Quaternary extraction system.
LF4-17	Include	Annually	Monitors potential bypass of contaminants through the Quaternary extraction system.
LF4-18	Include	Annually	Monitors potential bypass of contaminants through the Quaternary extraction system.
LF4-19	Include	Annually	Monitors potential bypass of contaminants through the Quaternary extraction system.
LF4WP6	Exclude		Monitors approximately the same zone as well LF4WP12; has 2.5-foot screen compared to a 5-foot screen at well LF4WP12.
LF4WP10	Include	Annually	Monitors potential bypass of contaminants through the Quaternary extraction system.
LF4WP11	Include	Annually	Monitors potential bypass of contaminants through the Quaternary extraction system.
LF4WP12	Include	Annually	Monitors potential bypass of contaminants through the Quaternary extraction system.
Wells Located Within the Landfill 4 Plume(s):			
LF4-4	Exclude		Well is located approximately 130 feet from well LF4-6; LF4-6 contains higher COC concentrations and is better suited to monitor the performance of the extraction system.
LF4-6	Include	Annually	Monitors the performance of the extraction system.
LF4-9	Exclude		Well is located close to (within 50 feet) extraction well RW-4; water quality is similar to that of RW-4.
LF4-12	Exclude		Well is located close to (within 50 feet) extraction well RW-3; water quality is similar to that of RW-3.
LF4-21	Exclude		Well is located close to (within 50 feet) extraction well RW-2; water quality is similar to that of RW-2; well LF4-6, located approximately 100 feet away contains high COC concentrations and is better suited to

TABLE 4.4 (Continued)
LANDFILL 4 MONITORING PROGRAM EVALUATION - QUATERNARY WELLS
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Include or Exclude Well	Recommended Sampling Frequency[a/]	Rationale for Including or Excluding a Well
			monitor the performance of the extraction system.
LF4-23	Include	Annually	Monitors the performance of the extraction system.
LF4-25	Exclude		Well is located relatively close (approximately 200 feet) to well LF4-23 that is being used to monitor extraction system performance.
LF4-27	Include	Annually	Monitors the performance of the extraction system.
LF4-30	Include	Annually	Defines outermost extent of TCE and CTCL contamination to the south.
LF4WP3	Exclude		Monitors approximately the same zone as well LF4-30; has 2.5-foot screen compared to a 10-foot screen at LF4-30.
LF4WP5	Exclude		Monitors approximately the same zone as well LF4WP8; has 2.5-foot screen compared to a 5-foot screen at LF4WP8.
LF4WP7	Include	Annually	Monitors the performance of the extraction system.
LF4WP8	Include	Annually	Monitors the performance of the extraction system.
LF4WP9	Include	Annually	Monitors the performance of the extraction system.

[a/] All wells in the Landfill 4 monitoring program are currently sampled annually.

TABLE 4.5
LANDFILL 4 MONITORING PROGRAM EVALUATION - UPPER PROVIDENCE WELLS
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Include or Exclude Well	Recommended Sampling Frequency[a/]	Rationale for Including or Excluding a Well
Wells Located Hydraulically Upgradient From OT-37 Source Area:			
none			
Wells Located Hydraulically Cross-Gradient of and Generally Outside of the OT-37 Plume(s):			
LF4-32ES	Exclude		Selected COCs generally below MCLs 13 times over the past 10 years.
LF4-33ES	Exclude		Selected COCs generally below MCLs 13 times over the past 10 years.
LF4PR3	Include	Annually	Well defines boundary of plume to the north.
Wells Located Hydraulically Downgradient of the Outermost Extent of the OT-37 Plume(s):			
LF4-3	Exclude		Well is located close to well LF4-5 (within 130 feet) and is screened in similar interval; selected COCs below MCLs over past 10 years.
LF4-5	Include	Annually	Well monitors potential future migration of OT-37 plume and potential vertical migration of Landfill 4 plume.
LF4-8	Include	Annually	Well monitors potential future migration of OT-37 plume and potential vertical migration of Landfill 4 plume.
LF4-11	Include	Annually	Well monitors potential future migration of OT-37 plume and potential vertical migration of Landfill 4 plume.
LF4-32	Exclude		Selected COCs have been below MCLs 13 times over past 10 years; well is located cross-gradient and downgradient of the plume.
LF4-34	Include	Biennially	Well monitors potential future migration of OT-37 plume and potential vertical migration of Landfill 4 plume.
LF4-36	Include	Biennially	Well monitors potential future migration of OT-37 plume and potential vertical migration of Landfill 4 plume.
LF4-38	Include	Biennially	Well monitors potential future migration of OT-37 plume and potential vertical migration of Landfill 4 plume.
LF4-40	Include	Annually	Well monitors potential future migration of OT-37 plume and potential vertical migration of Landfill 4 plume.
LF4-42	Include	Annually	Well monitors potential future migration of OT-37 plume and potential vertical migration of Landfill 4 plume.

TABLE 4.5 (Continued)
LANDFILL 4 MONITORING PROGRAM EVALUATION - UPPER PROVIDENCE WELLS
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Include or Exclude Well	Recommended Sampling Frequency[a/]	Rationale for Including or Excluding a Well
LF4-46	Include	Annually	Well monitors potential future migration of OT-37 plume and potential vertical migration of Landfill 4 plume.
RI1-5W	Exclude		Selected COCs have been below MCLs 12 times over past 10 years; well is located cross-gradient and downgradient of the plume.
RI1OW1	Exclude		Well is located close to well LF4-36 (within 150 feet) and is screened in similar interval; selected COCs below MCLs over past 6 years.
RI1PW1	Exclude		Well has a 50-foot screen; well LF4-36 is more suitable for monitoring that location; selected COCs below MCLs for past 5 years.
Wells Located Within the OT-37 Plume(s):			
LF4-14	Include	Annually	Defines boundary of plume to the north.
LF4-47	Include	Annually	Defines downgradient boundary of plume.
LF4-48	Include	Annually	Defines boundary of plume to the north.
LF4PR4	Include	Annually	Defines boundary of plume to the south.
RI1-2W	Include	Annually	Defines axis of plume, monitors slightly deeper zone than well S62MW1.
RI1-4W	Include	Annually	Defines boundary of the plume to the south.
RI1-6W	Exclude		Monitors similar water quality zone as well RI1-2W.
RI1-7W	Include	Annually	Defines boundary of the plume to the south.
S62MW1	Include	Annually	Defines axis of plume.
S62MW2	Exclude		Monitors similar water quality zone as well RI1-2W.
S62MW3	Include	Annually	Defines axis of plume.
S62MW4	Include	Annually	Defines boundary of plume to the north in a deeper zone.
S62MW5	Include	Annually	Defines most upgradient extent of plume.

[a/] All wells in the Landfill 4 monitoring program are currently sampled annually.

TABLE 4.6
LANDFILL 4 MONITORING PROGRAM EVALUATION
WELLS SCREENED BELOW THE UPPER PROVIDENCE UNIT
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Unit	Include or Exclude Well	Recommended Sampling Frequency[a/]	Rationale for Including or Excluding Well
LF4-7	LPROV	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37 and Landfill 4.
LF4-10	LPROV	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37 and Landfill 4.
LF4-33	LPROV	Exclude		Well is located cross-gradient of plumes in upper units; selected COCs have been below MCLs for the past 10 years.
LF4-34ES	LPROV	Exclude		Well is located cross-gradient of plumes in upper units; selected COCs have been below MCLs for the past 10 years.
LF4-35	LPROV	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37 and Landfill 4.
LF4-35ES	BLUFF	Exclude		Well is located cross-gradient of plumes in upper units; selected COCs have been below MCLs for the past 10 years.
LF4-36ES	BLUFF	Exclude		Well is located cross-gradient of plumes in upper units; selected COCs have been below MCLs for the past 10 years.
LF4-37	LPROV	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37 and Landfill 4.
LF4-39	LPROV	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37 and Landfill 4.
LF4-41	LPROV	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37 and Landfill 4.
LF4-43	LPROV	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37 and Landfill 4.
LF4-45	LPROV	Include	Biennially	Monitors potential vertical migration of contaminants from Landfill 4.
LF4BL1	BLUFF	Include	Biennially	Montiors potential vertical migration of contaminants from OT-37, although selected COCs have been below MCLs for the past 10 years.
LF4BL2	BLUFF	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37, although selected COCs have been below MCLs for the past 10 years.
LF4BL3	BLUFF	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37 and Landfill 4.
LF4BL4CU	CUSSETA	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37 and Landfill 4.
LF4BL5	BLUFF	Include	Biennially	Monitors potential vertical migration of contaminants from Landfill 4.
LF4BL6	BLUFF	Include	Biennially	Monitors potential vertical migration of contaminants from Landfill 4.
LF4BL7	BLUFF	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37 and Landfill 4.
LF4BL8	BLUFF	Include	Biennially	Monitors potential vertical migration of contaminants from Landfill 4.

TABLE 4.6 (Continued)
LANDFILL 4 MONITORING PROGRAM EVALUATION
WELLS SCREENED BELOW THE UPPER PROVIDENCE UNIT
ROBINS AFB
WARNER ROBINS, GEORGIA

Well ID	Unit	Include or Exclude Well	Recommended Sampling Frequncy[a/]	Rationale for Including or Excluding Well
LF4PR1	LPROV	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37, although selected COCs have been below MCLs for the past 10 years.
LF4PR2	LPROV	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37, although selected COCs have been below MCLs for the past 10 years.
RI1-1W	LPROV	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37.
RI1-3W	LPROV	Include	Biennially	Monitors potential vertical migration of contaminants from OT-37.

[a/] All wells in the Landfill 4 monitoring program are currently sampled annually.

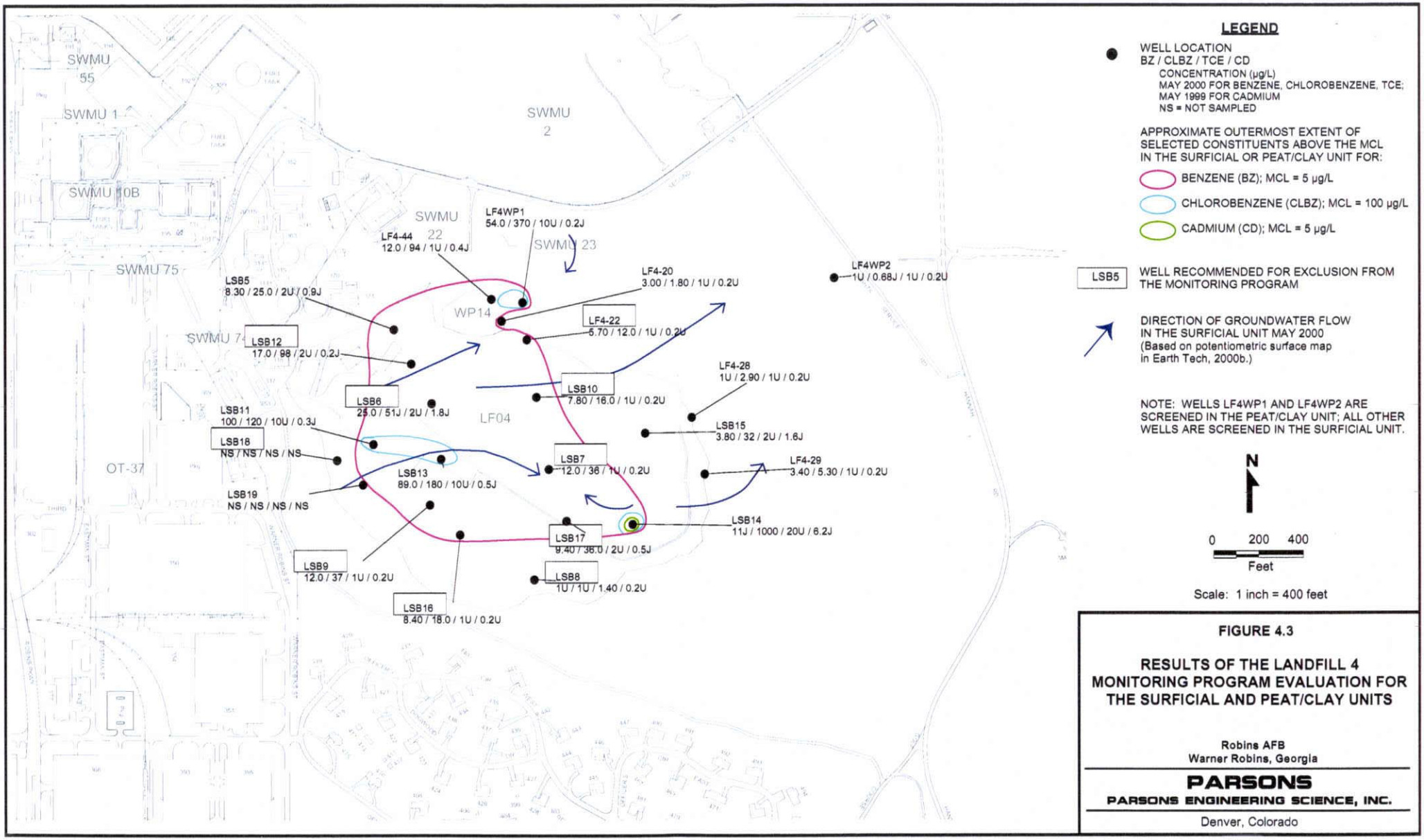

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FIGURE 4.3

RESULTS OF THE LANDFILL 4 MONITORING PROGRAM EVALUATION FOR THE SURFICIAL AND PEAT/CLAY UNITS

Robins AFB
Warner Robins, Georgia

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

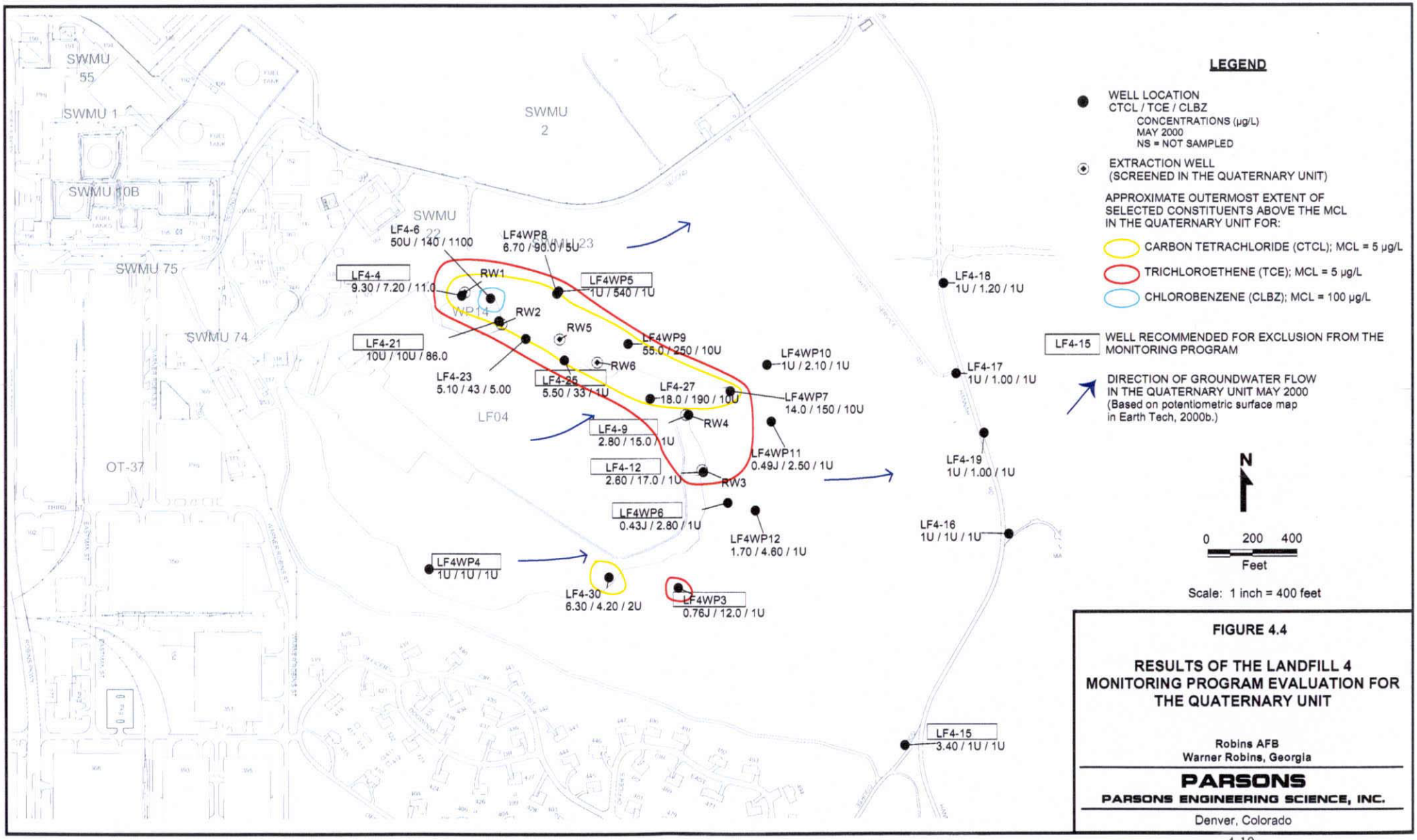

FIGURE 4.4

RESULTS OF THE LANDFILL 4 MONITORING PROGRAM EVALUATION FOR THE QUATERNARY UNIT

Robins AFB
Warner Robins, Georgia

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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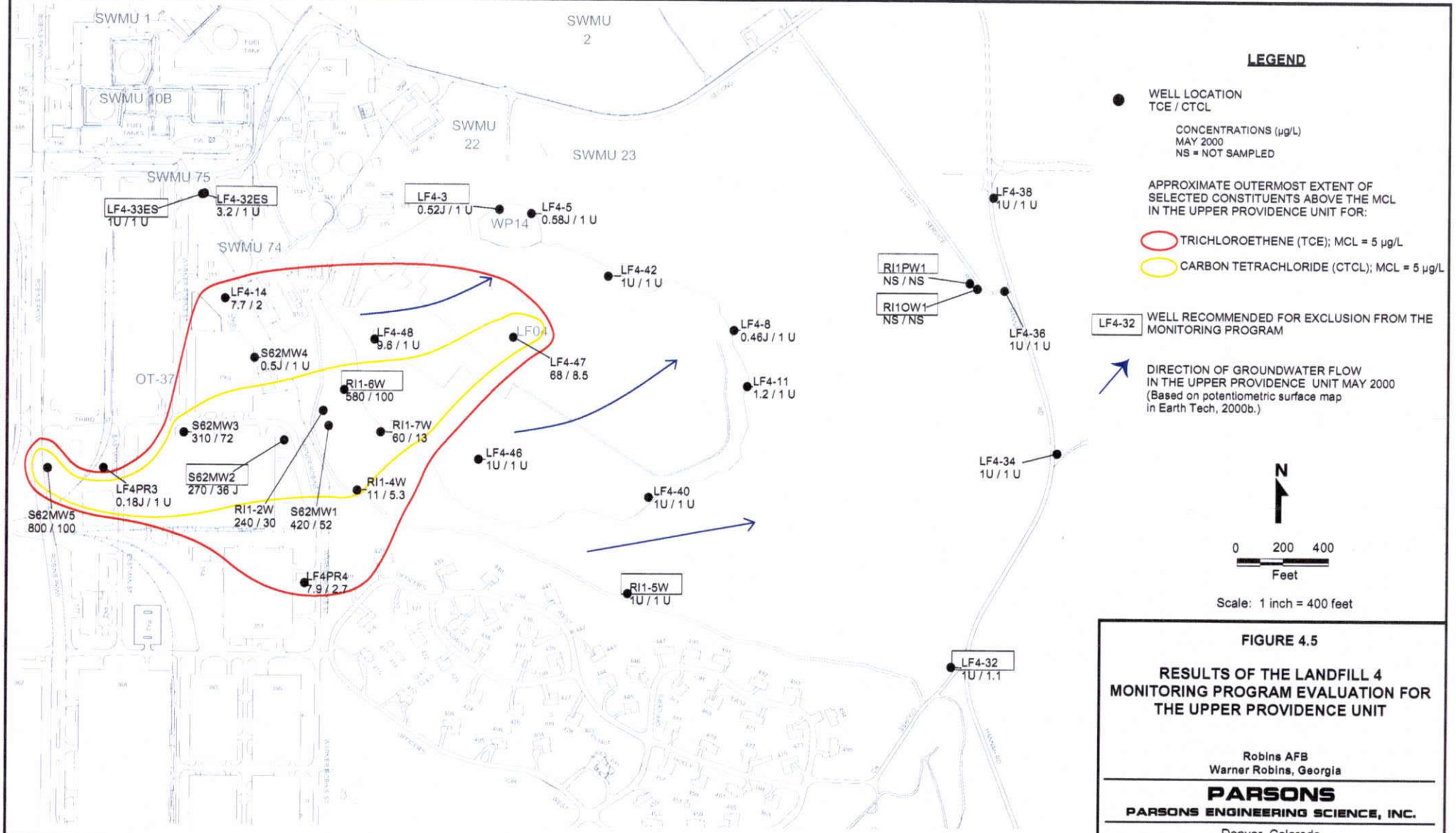

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FIGURE 4.5

RESULTS OF THE LANDFILL 4 MONITORING PROGRAM EVALUATION FOR THE UPPER PROVIDENCE UNIT

Robins AFB
Warner Robins, Georgia

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

that were retained were those that can be used to evaluate the effectiveness of natural attenuation in reducing the COC concentrations.

The 10 wells in the Quaternary unit were recommended for exclusion because: (1) the well is upgradient or cross-gradient of the plume and concentrations have been historically below MCLs, (2) a nearby well screened in the same zone is providing adequate or superior information, or (3) the well is located inside the remediation zone, but contains lower concentrations than other nearby wells and is thus less suitable for monitoring the performance of the remedial system (see Table 4.4). The Quaternary wells retained in the monitoring network are those that can be used to evaluate the performance of the Quaternary extraction system combined with natural attenuation in reducing contaminant concentrations.

The 9 wells in the upper Providence unit were recommended for exclusion because: (1) the well is upgradient or cross-gradient of the plume and concentrations have been historically below MCLs, or (2) a nearby well screened in the same zone is providing adequate or superior information (see Table 4.5). The plume in the upper Providence unit is attributed to an unknown source in the vicinity of the Third Street storm sewer (OT-37) and not LF-04. The monitoring wells in the upper Providence unit selected for inclusion in the monitoring network were those that can be used to define the extent of the OT-37 plume and monitor potential future migration. Also, wells in this unit were included to assess potential vertical migration of contaminants from plumes originating at LF-04 in the overlying units.

The 4 wells screened in the units underlying the upper Providence unit were recommended for exclusion because: (1) the well is upgradient or cross-gradient of the plumes in the overlying units and concentrations have been historically below MCLs, (2) the well is not horizontal or vertically downgradient of plumes in overlying units, thus it is not useful for monitoring the potential for vertical migration of contaminants, or (3) a nearby well screened in the same zone is providing adequate or superior information (see Table 4.6).

The wells recommended for exclusion from the monitoring program are not recommended for plug and abandonment at this time. Over the course of site remediation and closure, it is likely that these wells will need to be sampled again to confirm that site cleanup goals have been maintained or met at those locations. Measurement of water levels should be continued in the excluded wells to provide information on the performance of plume migration control measures in place.

4.2.2 Sampling Frequency Evaluation

It is recommended that the annual sampling frequency for the LF-04 monitoring wells remain the same for the majority of the wells, and be reduced to biennially for a portion of the wells. A reduction of sampling frequency from annually to biennially is recommended for the following wells due to their relatively large distance from the contaminant source: (1) one well screened in the peat/clay unit (LF4WP2) that is located over 1,000 feet downgradient from the surficial unit plumes (Table 4.3), (2) three wells located in the upper Providence unit that are designated to monitor the point of compliance at Hannah Road approximately 2,000 feet downgradient of the upper Providence plumes (Table 4.5), and (3) all 20 wells screened below the upper Providence because it is not likely that significant contamination will migrate to these deeper units due to the predominantly upward hydraulic gradient (see Section 4.1).

4.2.3 Analyte Suite Review

Groundwater samples collected at LF-04 are currently being analyzed for VOCs and TAL compounds in all the wells, and SVOCs and pesticides/PCBs in a subset of wells. The final list of COCs for LF-04 (Table 2, Earth Tech, 2000a) does not include any SVOC or pesticide/PCB compounds; therefore, it is recommended that these suites of analyses be eliminated from the monitoring program. It is also recommended that analyses of cyanide and mercury be discontinued because they also are not COCs in groundwater at site LF-04.

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

Recommendations to streamline the current groundwater monitoring programs at Robins AFB were presented in Sections 2 through 4. These recommendations consisted of (1) excluding selected wells from the monitoring network because they are no longer providing enough information to justify continued sampling, (2) reducing the sampling frequency of selected wells, and (3) eliminating certain suites of analytes because they do not include COCs or because the analytes typically are not detected above MCLs. Table 5.1 summarizes the recommended sampling program modifications for the three sites evaluated. For comparison, the current monitoring programs also are summarized on Table 5.1. If these recommendations are implemented, the number of wells sampled per year would be reduced from 264 to 136 and the number of groundwater sample analyses per year would be reduced from 642 to 168.

The potential cost savings associated with each recommendation was estimated and presented on Table 5.2. The current total monitoring cost for the three monitoring programs is estimated to be approximately $548,000 per year. The estimated total monitoring cost based on the recommended monitoring programs is approximately $251,000 per year, or a savings of approximately $297,000 per year. If remediation of the three sites were to continue for 30 years, the total cost savings would be $8.9 million (present value).

It is recommended that presentations be prepared for inclusion in an annual report for each site displaying the historical groundwater quality data collected from wells that will be excluded from the monitoring network. This could be achieved by preparing a map for each monitoring zone showing the historically highest detected concentration from each well that has been part of the monitoring network since its inception, and constructing plume boundaries based on these data. The purpose of this documentation is

TABLE 5.1
SUMMARY OF RECOMMENDED SAMPLING PROGRAM MODIFICATIONS
ROBINS AFB
WARNER ROBINS, GEORGIA

	Current Monitoring					Recommended Monitoring					
Site	Total No. of Wells Currently Sampled	Sampling Frequency	Total No. of Wells Sampled per Year	No. of Analyses per Year[a/]	Analyses	Total No. of Wells Excluded	Total No. of Wells Remaining	Sampling Frequency	No. of Wells Sampled per Year	No. of Analyses per Year	Analyses
OT-17	44	Semi-annual	88	88 88 88	VOC SVOC P	6	38	Annual	38	38 0 0	VOC SVOC P
LF-03	38	Semi-annual	76	76 76 76	VOC SVOC P	7	31	Annual-VOC Biennial-SVOC,P	31	31 16[b/] 16[b/]	VOC SVOC P
LF-04	100	Annual	100	100 25 25	VOC,TAL PAH Pest/PCB	33	67	Annual	67	67	VOCs, TAL (no CN,Hg)
Totals	**182**		**264**	**642**		**46**	**136**		**136**	**168**	

a/ The "No. of Analyses per Year" are estimated from Table 1-1 of Earth Tech 1999.

b/ For samples analyzed biennially, the "No. of Analyses per Year" is considered to be one-half the total number of samples analyzed biennially.

VOC = Volatile organic compound
SVOC = Semi-volatile organic compound
P = Priority pollutant metals
PAH = Polynuclear aromatic hydrocarbons
TAL = Target analyte list
Pest/PCB = Pesticides/PCBs

TABLE 5.2
COST COMPARISON SUMMARY
ROBINS AFB
WARNER ROBINS, GEORGIA

		OT-17		LF-03		LF-04	
		Current Program	Recommended Program	Current Program	Recommended Program	Current Program	Recommended Program
No. Wells Sampled per Year		88	38	76	31	100	67
Sampling Costs[a/] (No. Wells Sampled x $1500)		$132,000	$57,000	$114,000	$46,500	$150,000	$100,500
VOC[b/]	No. Samples/Year	88	38	76	31	100	67
	x $150	$13,200	$5,700	$11,400	$4,650	$15,000	$10,050
SVOC[c/]	No. Samples/Year	88		76	16		
	x $250	$22,000		$19,000	$4,000		
PAH[d/]	No. Samples/Year					25	
	x $150					$3,750	
PP[e/]	No. Samples/Year	88		76	16		
	x $150	$13,200		$11,400	$2,400		
TAL[f/]	No. Samples/Year					100	67
	x $300					$30,000	$20,100
TAL-Hg[g/]	No. Samples/Year					100	
	x $25					$2,500	
TAL-CN[h/]	No. Samples/Year					100	
	x $35					$3,500	
Pest[i/]	No. Samples/Year					25	
	x $140					$3,500	
PCB[j/]	No. Samples/Year					25	
	x $140					$3,500	
TPH[k/]	No. Samples/Year						
	x $150						
Total Cost		**$180,400**	**$62,700**	**$155,800**	**$57,550**	**$211,750**	**$130,650**

Total Estimated Cost for Current Program	**$547,950**	**per year**
Total Estimated Cost for Recommended Program	**$250,900**	**per year**

[a/] The sampling cost of $1500 per well includes: 1) labor for sampling, data validation, and data management/reporting and 2) other direct costs such as sampling equipment rental (PID, pH/Eh, O_2/CO_2, etc.), vehicle rental, and miscellaneous field supplies. It is assumed that 5 wells can be sampled in one day. No laboratory costs are included in this amount.

[b/] VOC analyses by Method 8260.

[c/] SVOC analyses by Method SW8270C.

[d/] PAH analyses by Method SW8310.

[e/] PP (Priority pollutant) metals analyses by method SW6010/7000.

[f/] TAL analyses by Method SW6010/7000.

[g/] TAL-mercury analyses by Method SW7470.

[h/] TAL-cyanide analyses by Method SW9010B .

[i/] Pesticide analyses by Method SW8081.

[j/] PCB analyses by Method SW8082.

[k/] TPH analyses by Method SW8015.

to avoid the appearance of data gaps in the annual report presentations prepared after the monitoring network has been reduced.

At this time, plug and abandonment of wells excluded from the monitoring programs at these three sites is not recommended. Data may be needed from some of the excluded wells in the future to support evaluations for remedial operations or site closure. In addition, it would be useful to continue water level monitoring in these wells on an annual basis.

SECTION 6

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